

INFORMATION REPORT

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REPORT

SUBJECT Manuals and Documents on the Czech  
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of BK3 and BK5 universal grinders produced in

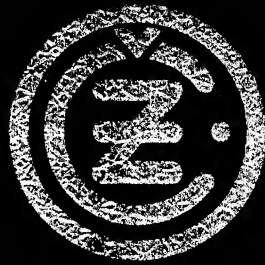
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INFORMATION REPORT INFORMATION REPORT



UNIVERSAL CYLINDRICAL GRINDING MACHINES

**Model BK 3, BK 5**

**CZECH ARMS FACTORY STRANDEK**

REPUBLIC OF CZECHOSLOVAKIA

(CZECHOSLOVAKIA)



UNIVERSAL CYLINDRICAL GRINDING MACHINES Model BK 3, BK 5

1

# OPERATOR'S HANDBOOK

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Model .....

Serial No. of Machine .....

Manufacturer .....

Date .....

Serie No. ....

This Operator's Handbook is to be passed first of all to the Operator who will be entrusted with the attendance of the machine. If filed, it cannot, of course, meet its purpose. That is why we are sending two copies of it with each machine, of which one for the Operator, the other for your file.

As we are constantly improving our products, description, illustrations and other data contained in this handbook may differ from the latest execution of the machine and are not binding in details.

When ordering spare parts, kindly state serial number of the machine which is stamped to the right at the face of bottom table.

**CZECH ARMS FACTORY STRAKONICE**  
National Corporation (Czechoslovakia)



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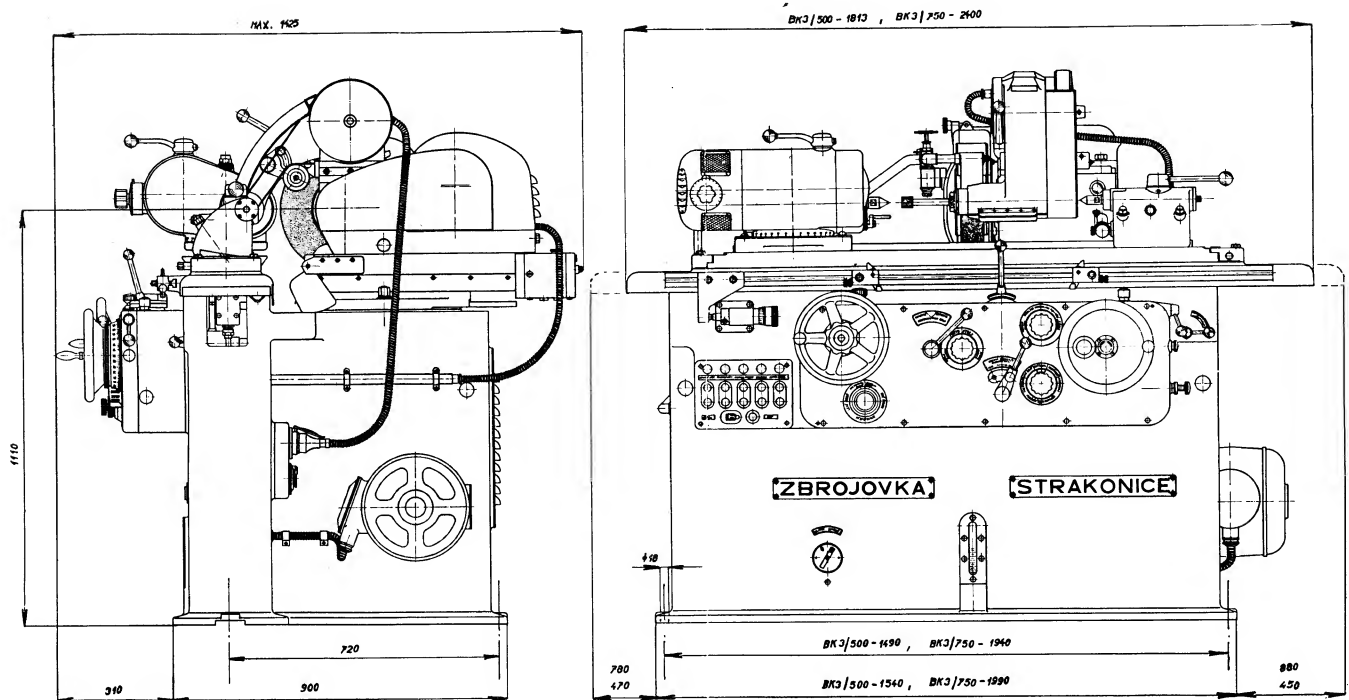


Fig. 1.

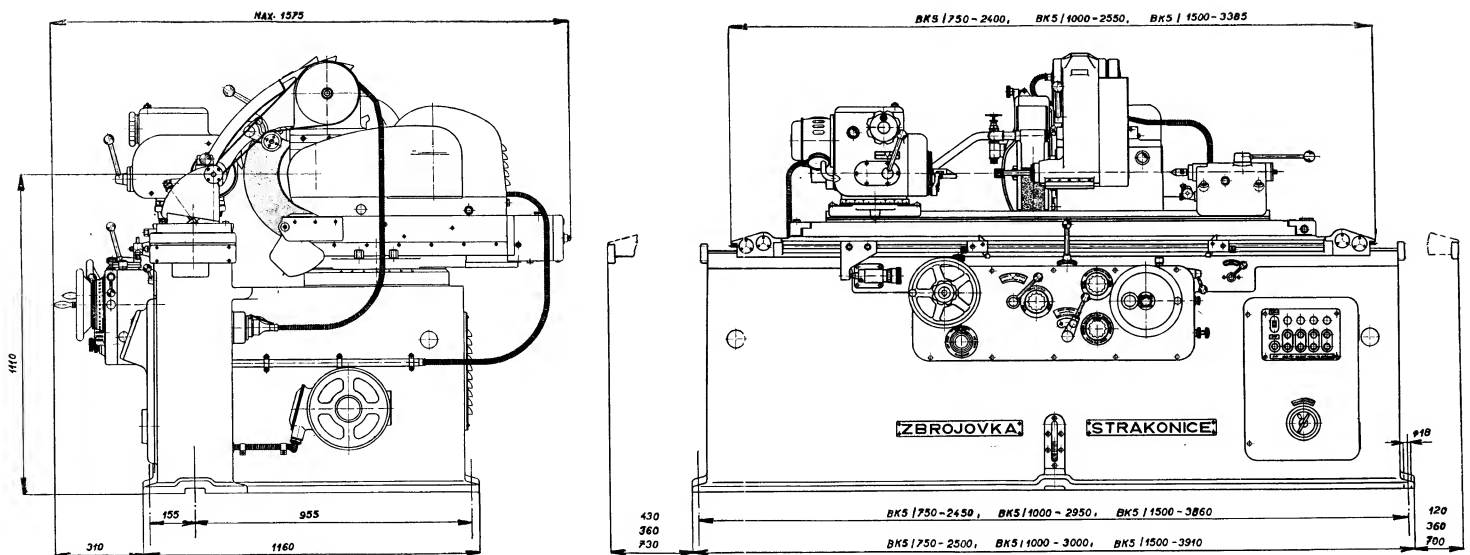


Fig. 1a.



## UNIVERSAL CYLINDRICAL GRINDING MACHINES Model BK 3, BK 5

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Specifications of Model BK 3	500	750
Distance between centres . . . . .	20"	30"
Maximum swing of work . . . . .	10"	10"
Standard wheel dimensions (diameterxwidth/hole) . . . . .	13 <sup>3</sup> / <sub>4</sub> "X2 <sup>3</sup> / <sub>8</sub> "X5"	13 <sup>3</sup> / <sub>4</sub> "X2 <sup>3</sup> / <sub>8</sub> "X5"
Minimum diameter of wheel after wear . . . . .	9 <sup>1</sup> / <sub>4</sub> "	9 <sup>1</sup> / <sub>4</sub> "
Clamping capacity of rests . . . . .	2 <sup>3</sup> / <sub>4</sub> "	2 <sup>3</sup> / <sub>4</sub> "
Taper in work spindle Morse No. . . . .	4	4
Taper in tailstock spindle Morse No. . . . .	3	3
Diameter of chuck . . . . .	5 <sup>1</sup> / <sub>2</sub> "	5 <sup>1</sup> / <sub>2</sub> "
Diameter of internal grinding spindle . . . . .	2 <sup>3</sup> / <sub>4</sub> "	2 <sup>3</sup> / <sub>4</sub> "
Work headstock swivels by . . . . .	90°	90°
Wheelhead swivels by . . . . .	30°	30°
Table swivels by . . . . .	6°	6°
Longitudinal travel of table . . . . .	25 <sup>1</sup> / <sub>2</sub> "	35 <sup>1</sup> / <sub>2</sub> "
Minimum movement of table, longitudinally . . . . .	1/8"	1/8"
Coarse feed of table per 1 rev. of handwheel . . . . .	1"	1"
Fine feed of table per 1 rev. of micrometric screw . . . . .	0.02"	0.02"
Cross travel of wheelhead . . . . .	3 <sup>1</sup> / <sub>2</sub> "	3 <sup>1</sup> / <sub>2</sub> "
Quick withdrawal or approach of wheelhead . . . . .	1 <sup>3</sup> / <sub>4</sub> "	1 <sup>3</sup> / <sub>4</sub> "
Wheelhead adjustable on wheel slide . . . . .	4"	4"
RPM of grinding wheel . . . . .	1850	1850
Speeds of work (infinitely variable) . . . . .	50 - 750	50 - 750
Table traverse per minute . . . . .	4" - 315"	4" - 315"
Independent feed of wheelhead at reversal . . . . .	.0002" - .0011"	.0002" - .0011"
Independent plunge cut feed of wheelhead . . . . .	.002 - .04	.002 - .04
Capacity of oil tank for hydraulic system . . . . .	11 galls.	11 galls.
RPM of workhead motor . . . . .	100-2800	100-2800
RPM of wheelhead motor . . . . .	1420	1420
RPM of motor for internal grinding attacht . . . . .	2800	2800
RPM of hydraulic system motor . . . . .	690	690
RPM of coolant pump motor . . . . .	2800	2800
Output of workhead motor . . . . .	0.6 <b>0.72</b>	0.6 <b>0.72</b>
Output of wheelhead motor . . . . .	2.4	2.4
Output of motor for the drive of internal grinding spindle . . . . .	<b>x 0.5</b>	<b>x 0.55</b>
Output of hydraulic system motor . . . . .	1.5	1.5
Output of coolant pump motor . . . . .	0.2 <b>0.25</b>	0.2 <b>0.25</b>
Floor space required (length x width) . . . . .	8'16"X5'	10'10"X5'
Weight of machine with stand, equipment . . . . .	4629 lbs.	5070 lbs

*Standard Equipment*

1 centre Morse No. 3. 1 centre Morse No. 4. 1 grinding wheel with balancing flange. 1 device for dismounting flange. 1 open rest. 1 closed rest. 1 diamond holder without diamond. 3 guards. 1 balancing mandrel. 1 set of wrenches. 1 grease gun.

*Optional Equipment*

(supplied only on special order.)

Swinging-out internal grinding attachment. Internal grinding spindle and extensions. Three-jaw chuck with flange. Quick-acting collet chuck including cooling attachment. Collets for quick clamping any required work diameter from 6 to 20 mm (abt. 1/4" - 3/4").

Balancing flange for external grinding wheel. Grinding wheel. Balancing flange for internal grinding wheel. Stand for balancing grinding wheels. Truing attachment. Micrometric stop. Spot light for A. C. 220 Volts.

**Elektromagnetic chuck, dia. 200 mm, with rectifier-power supply  
220 Volts - 50 per.**

**CZECH ARMS FACTORY STRAKONICE**  
National Corporation (Czechoslovakia)



Specifications of Model BK 5	750	1000	1500
Distance between centres . . . . .	30"	40"	60"
Maximum swing of work . . . . .	12 1/2"	12 1/2"	12 1/2"
Standard wheel dimensions (diameterxwidth/hole) . . . . .	20"X3"X8"	20"X3"X8"	20"X3"X8"
Minimum diameter of wheel after wear . . . . .	12 1/2"	12 1/2"	12 1/2"
Clamping capacity of rests . . . . .	4"	4"	4"
Taper in work spindle Morse No. . . . .	4	4	4
Taper in tailstock spindle Morse No. . . . .	3	3	3
Diameter of chuck . . . . .	5 1/2"	5 1/2"	5 1/2"
Diameter of internal grinding spindle . . . . .	2 3/4"	2 3/4"	2 3/4"
Work headstock swivels by . . . . .	90°	90°	90°
Wheelhead swivels by . . . . .	30°	30°	30°
Table swivels by . . . . .	6°	6°	6°
Longitudinal travel of table . . . . .	32"	46"	66"
Minimum movement of table, longitudinally . . . . .	1/8"	1/8"	1/8"
Coarse feed of table per 1 rev. of handwheel . . . . .	1"	1"	1"
Fine feed of table per 1 rev. of micrometric screw . . . . .	.002"	.02"	.02"
Cross travel of wheelhead . . . . .	5 1/2"	5 1/2"	5 1/2"
Quick withdrawal or approach of wheelhead . . . . .	1 3/4"	1 3/4"	1 3/4"
Wheelhead adjustable on wheel slide . . . . .	5 1/2"	5 1/2"	5 1/2"
RPM of grinding wheel . . . . .	1150	1150	1150
Speeds of work (infinitely variable) . . . . .	20, 30, 60, 95, 150, 240, 380, 600	20, 30, 60, 95, 150, 240, 380, 600	20, 30, 60, 95, 150, 240, 380, 600
Table traverse per minute . . . . .	4" to 236"	4" to 236"	4" to 236"
Independent feed of wheelhead at reversal . . . . .	.0002" - .0011"	.0002" - .0011"	.0002" - .0011"
Independent plunge cut feed of wheelhead . . . . .	.002" - .04"	.002" - .04"	.002" - .04"
Capacity of oil tank for hydraulic system . . . . .	18 galls	18 galls	18 galls
RPM of workhead motor . . . . .	1420	1420	1420
RPM of wheelhead motor . . . . .	1420	1420	1420
RPM of motor for internal grinding attacht . . . . .	2800	2800	2800
RPM of hydraulic system motor . . . . .	690	690	690
RPM of coolant pump motor . . . . .	2800	2800	2800
Output of workhead motor . . . . .	0.36	0.36	0.36
Output of wheelhead motor . . . . .	4.2	4.2	4.2
Output of motor for the drive of internal grinding spindle . . . . .	1.4	1.4	1.4
Output of hydraulic system motor . . . . .	1.5	1.5	1.5
Output of coolant pump motor . . . . .	0.2 <del>25</del>	0.2 <del>25</del>	0.5
Floor space required (length x width) . . . . .	10'2"X6'10"	11'9"X6'10"	17'9"X6'10"
Weight of machine with stand. equipment . . . . .	7165 lbs	7605 lbs	8487 lbs

#### Standard Equipment

1 centre Morse No. 3. 1 centre Morse No. 4. 1 grinding wheel with balancing flange. 1 device for dismounting flange. 1 open rest. 1 closed rest. 1 diamond holder without diamond. 3 guards. 1 balancing mandrel. 1 set of wrenches. 1 grease gun.

#### Optional Equipment

(supplied only on special order.)

Swinging-out internal grinding attachment. Internal grinding spindle and extensions. Three-jaw chuck with flange. Quick-acting collet chuck including cooling attachment. Collets for quick clamping any required work diameter from 6 to 20 mm (abt. 1/4" - 3/4").

Balancing flange for external grinding wheel. Grinding wheel. Balancing flange for internal grinding wheel. Stand for balancing grinding wheels. Truing attachment. Micrometric stop. Spot light for A. C. 220 Volts.

**Elektromagnetic chuck, dia. 200 mm, with rectifier-power supply  
220 Volts - 50 per.**

**CZECH ARMS FACTORY STRAKONICE**  
National Corporation (Czechoslovakia)





### b) GENERAL DESCRIPTION.

Fig. 3—4, 3a—4a.

This machine has been designed for precision grinding of cylindrical and conical work up to max. length (20", 30"), 30", 40", 60", respectively, and is especially suitable for continuous production. It is built to the Accuracy Limits **valid for Precision Machine Tools. Control by push-buttons is located on control panel.**

The machine allows for grinding between centres or in chuck and is as well suitable for internal grinding after mounting a special attachment on work headstock.

The internal grinding attachment may be swung out so that it does not hinder at cylindrical grinding and, on the other hand, by simply swinging it down the machine is instantly ready for internal grinding.

**Machine bed 4** is of rigid proportions and amply reinforced by ribbing. The table slideways are efficiently protected against grit and dust and are automatically lubricated by oiling rollers. The interior of bed serves for oil tank of the hydraulic system.

**Table** is of double design. Top table 67 is capable of being swivelled to a scale provided on bottom table 66 by means of screw 98. An accurately machined upper guide way guarantees for a perfect alignment of work headstock with tailstock even after a long service. A T-slot is provided at the face of bottom table in which there are located adjustable stops 73 for limiting table travel.

**Wheel slide 608** is traversed along in its guide ways which are arranged to swivel on bed. The guide ways of wheel slide are wide and automatically oiled from a self-contained oil tank. Transmission of power for the wheel slide traverse is over screw spindle and screw wheel 692. Backlash is hydraulically eliminated by means of regulation piston 687. Wheel slide 608 together with its guide ways 607 may be swivelled on bed up to 60°.

Wheel slide can be quickly approached to and returned from work. The new approach of wheel slide to work is accurate within .000 04". This considerably reduces the working time and allows the operator to measure, load and unload with safety.

Automatic withdrawal of grinding wheel by the amount of stock to be removed at quick run-back prevents the grinding wheel from knocking against work at the new quick approach.

**Wheel headstock 797** is adjustable on its slide (by means of gearing 853)\* and is locked in position by two bolts 833. Wheel spindle 863 is of Nitralloy Steel, ground and lapped and is running in adjustable plain bearings 820 which are automatically lubricated with oil delivered to them by pump 798 located inside the wheelhead. The supply of oil to wheel spindle bearings may be observed in gauge 922. Wheel flange is fitted with a slot to take up balancing insertions 811.

Grinding wheel is protected by guard 814, which may be dislocated towards wheel according to its wear. Wheel is easily accessible.

Motor 1653 for wheel spindle drive is of standard, bracket design. V-belts may be tensioned, if necessary, by dislocating motor which is done by means of screw 946, without tensioning rollers. Motor together with belt drive are located under cover 809.

\*) for model BK 3 only.



**Work headstock 998** is used both for external and internal grinding. It may be swivelled on its baseplate to a scale up to 60°. Its zero position is being secured by locking pin 1091. Work spindle of Nitralloy steel is mounted in plain bearings 1020, 1021 and may be firmly locked, when grinding between dead centres, by means of bolt 1047.

On model BK 3 the drive is by regulation motor 1652. There is no gearing applied in workhead which contributes to the working accuracy. The transmission of power from motor to work spindle is by V-belts which may be tensioned by hand nut 1072 without it being necessary to apply any tool. The speed of motor is infinitely varied thus allowing for the use of the most suitable speed for the diameter of work machined. Transformer 1678 to motor 1652 is housed in the machine bed 4. Hand wheel for setting the required speed of motor 1652 is fitted directly on the latter. The work is set into rotation or immobilized by lever 1011 which operates the motor clutch. Lever 1011 is located at the workhead 998.\*) (Fig 5)

On model BK 5 the drive to work spindle is from flange motor 1652 over gear box. Handwheel 1010 gives a selection of eight speeds of work spindle 1025. RPM of spindle are visible in an opening provided. Work piece is set into rotation or stopped by lever 1095 located on workhead 998. The same lever actuates also the brake so that work piece is stopped instantaneously.

An oil pump provides for automatic lubrication of workhead. Oil flow may be observed in gauge 1180.\*\*)

**Tailstock spindle 1235** is ejected and pulled in by lever 1247. Tailstock spindle together with centre 1270 are being pressed against the work by a spring the tension of which is adjustable by screw 1251. Tailstock spindle may be secured in any position by depressing lever 1247 and after releasing the latter the tailstock spindle will be ejected by the spring.

**Centrifugal coolant pump** with self-contained motor is located together with coolant tank apart of machine for the sake of easy cleaning.

**Swing arm 1835** of internal grinding attachment, supplied only to special order, is mounted on wheelhead 797. In a simple fashion it is brought into working position in which it is secured by lever 1852. The drive to internal grinding spindle is from special self-contained motor.

**Micrometric diamond holder 1536** is mounted on the tailstock or hinged on the holder which is fixed in the slot of top table 67.

**Pressure pump 1308** providing pressure oil accepts its drive directly from self-contained flange motor 1654. The three-way pump supplies pressure oil for the drive of table traverse, independent wheel feed and eliminating backlash in wheel slide gearing. The individual pressures may be adjusted by means of valves 1340. An ample oil tank is housed in the machine stand 4. By this arrangement pressure oil is conveniently cooled.

**Table traverse** is either hydraulic or by hand. Power feed is put on or off by lever 269 which simultaneously engages or disengages handfeed. This is carried out by pressure oil. Handfeed is either normal by handwheel 179 or fine over screw transmission for facing. Power feed is infinitely variable from 4" to 19'8" per minute. Table may dwell for any period in the left or right reversing point, or in both of them.

\*) for model BK 3 only.

\*\*) for model BK 5 only.



**Feed in cut** is either by handwheel 174 or automatically. Besides, when setting the machine or at finish grinding, wheel may be fed by .0002" by a special push-button 298.

Automatic feed of wheel proceeds either at reversal, i. e. depending on table traverse, or independently on it in plunge cut grinding.

Feed at reversal may proceed either in the left or in the right reversing point or in both of them. Independent feed is possible both at table traverse or when table stopped.

At any kind of automatic feed of wheel, i. e. at reversal or independent on table traverse, the feed rate may be set from .0002" to .0008".

Speed of independent feed may be set from .002" to .04" per minute.

**Hydraulic control** is centralised on panel 173. All hydraulic operated motions are infinitely variable and smooth. When grinding individual work pieces the operation of the machine may be performed either separately for each group or by a single lever i. e. after withdrawal of wheel the traverse of table and workhead as well as coolant supply will be put off.

At large batch production the single lever operation is extended also on approach of wheel by the amount of stock to be removed.

**Electric equipment** consists of:

- 1 electric motor (2.4 kW\*) 4,2 kW for the drive of wheel spindle,
- 1 electric motor (0.36 kW\*) 0,36 kW for the drive of work spindle,
- 1 electric motor 1,5 kW for the drive of pressure pump,
- 1 electric motor 0.15 kW for the drive of coolant pump.

To special order may be supplied:

- 1 electric motor (1kW\*) 1,4 kW for the drive of internal grinding spindle.

All electric motors are fitted with remote push-button control in connection with air contactors. Motors are secured against overload by protecting relay and warm release. **protected against short-circuit by fuses.**

Unless not otherwise desired, machine will be supplied with electric equipment for A. C. 380 V, 50 cycles.

#### c) TRANSPORT OF THE MACHINE.

The machine is despatched in protecting packing, all live parts being secured.

Size of packing according to distance between centress: (6'7" x 5'3" x 6'1", 8' x 5'3" x 6'1"\*) , 9' x 6'3" x 6'5", 10'8" x 6'3" x 6'5", 13'7" x 6'3" x 6'5".

Weight of machine packed according to distance between centres:  
(5.304 lbs, 5.965 lbs\*), 8.046 lbs, 8.598 lbs, 9.920 lbs.

Net weight of machine according to distance between centres:  
(4.629 lbs, 5.070 lbs\*), 7.165 lbs, 7.605 lbs, 8.487 lbs.

Immediately after its arrival check machine and accessory according to packing sheet enclosed. Make sure machine has not been damaged during transport. Advise us of damages or lack of accessory without delay.

Provision is made for easy hanging the machine on crane.

\*) for model BK 3 only.



## d) ERECTION.

Fig. 2—2a.

Generally, the machine is erected directly on the floor without it being necessary to apply foundation bolts and then grouted with thin cement mortar. Only if the floor could not dependably bear the weight of the machine, provide foundation of bricks or concrete. Dimensions of it are given in fig. 2—2a.

Machine is leveled in putting level (sensibility 0,03 to 0,05 mm on 1 m which equals to .0004" on 1 ft) on bed ways. Use steel wedges (1:20) to bring the machine into level. After the machine is level grout its bed with a thin layer of concrete checking all the time the machine level and allow concrete to turn thoroughly solid.

(Previous to leveling the machine traverse the table by hand to its middle position and remove nut 558 of piston rod 539. Then traverse the table by about 4" to the right to throw the piston rod 539 out of its guiding lug on table 66. Now lift the table and push wooden blocks under it to prevent its slide ways from being damaged.\*)

When leveling the machine lift cloth cover 126 together with gib 91 protecting guide ways on bed. Then traverse table to either of its extreme end positions to gain enough place for the level.

After solidification of the concrete foundation connect machine on service line. The mains are connected to switchboard in electric distributor.

\*) for model BK 3 only.

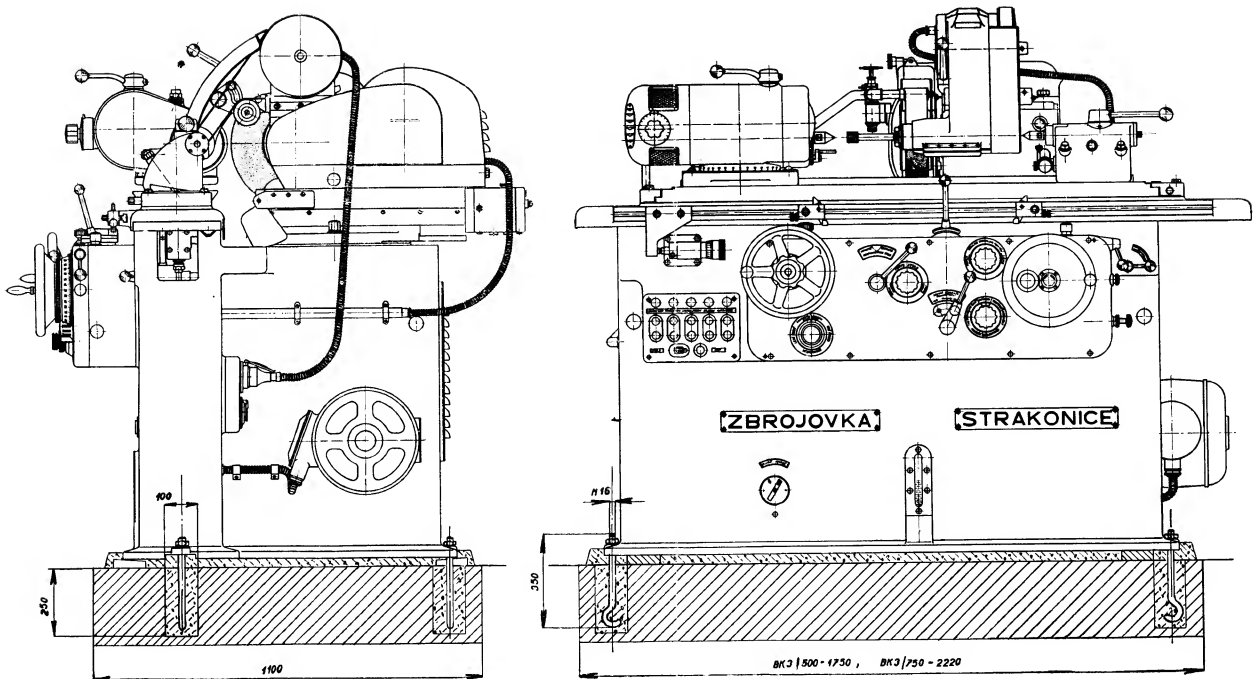


Fig. 2.





## II. OPERATION.

### a) CARE OF MACHINE.

Provide all lubricating points on machine with respective lubricant. Renew oil in wheel headstock after first month of service, i. e. after some 500 hours of work, later on each sixmonth. Clean tank at each oil renewal.

Pump out pressure oil each sixmonth and have it filtered. Clean tank and refill it with oil. Tighten all threaded connections on piping after first two months of service, later on each sixmonth. Loose connections allow air to get in piping of cylinder which causes faulty working cycle.

In general, keep the whole machine as clean as possible. At least twice a week clean table and put some grease under it as well as under wheel headstock and tailstock to avoid corrosion of machined surfaces which are exposed to coolant. At interrupted service of the machine clean and grease table before each pause.

Avoid putting of wrenches and other objects on table. A shock may injure its working surface and, consequently, affect the accuracy of the whole machine.

Use duster for cleaning the machine, avoid applying of compressed air or cleaning wool for this purpose.

Before starting the machine make yourself well acquainted with all its controls. From the first moment care for ample lubrication.

The accuracy of each machine is carefully being tested before despatch from our works. An Inspection Sheet covering all data of the test performed is despatched with each machine.

### b) LUBRICATION.

For lubrication of table and wheel slide guides, wheel and work spindles and tailstock spindle use lubricant as per List of lubricants recommended, page 43.

Check oil in oil pockets of the slide ways on bed each month, oil in tanks of wheel slide, wheelhead and work headstock once a week and, if necessary, complete the filling. (Oil work spindle each 8 hours, provided that grinding between dead centres is not performed.\*) Oil the tailstock spindle after each 8 working hours.

\*) for model BK 3 only.



### c) PUTTING THE MACHINE INTO SERVICE.

Fig. 3—4, 3a—4a.

Before starting clean properly the whole machine, especially all slide ways from anti-corrosion paint. Pour oil for hydraulic system into bed 4. Tank holds about 85 liters = 18<sup>3</sup>/<sub>4</sub> galls. (50 liters = 11 galls\*). Machine is supplied without oil. Maximum and minimum oil level gives oil gauge 13 at the front side of bed. Keep oil level always between the two marks.

Pour some 4 liters = 1 gal. (2,5 l = 1/2 gal.\*) of oil into wheel headstock. Keep oil level between the two marks on bar of screw plug 838.

Pour about 0,3 liter = 20 cub. in. of oil into tank 609 of wheel slide for lubrication of slide ways of wheel slide 608. Keep oil level in the middle of gauge 725 located on tank at the rear side of wheel slide.

Oil the work spindle bearings.\*)

Pour some 1,5 l = 1/3 gall. oil for lubrication of work spindle bearings into workhead housing 998.

Oil level is to be kept about in the middle of oil gauge 1179 located to the left at the workhead.

Oil the tailstock spindle.

Traverse wheel head 797 on wheel slide backward.

Stop oil supply into cylinder 525 of hydraulic drive to table 66 by means of regulating wheel 224. Set wheel 225 which operates automatic feed of wheel in cut to "off" position. This will put off the power feed and automatically engage the handfeed. Lever 639 put to "return" position.

Start pressure pump motor.

By handwheel 174 traverse wheel slide 608 to extreme rear position and then back it in the same way to the other end position. Repeat this several times.

Make sure machine is correctly connected on main service line.

Electric motor 1654 for the drive of pressure pump 1308 has to run in the direction of arrow provided on same. Set control lever 269 to "on" position and traverse table by means of handwheel 224, in the beginning slowly, later on faster.

Movement of table 66 must be smooth, without vibrations. Vibrations of the table indicate presence of air in cylinder 525 from which it is to be driven out. This is done in following way: Traverse wheel slide 608 with wheel head 797 to its rear end position. Traverse table by hand from one extreme end position into the other. Make sure the grinding wheel will not knock at this against work headstock or tailstock. Stops 73 for limiting table travel put off in depressing their upper end previous to knocking of the respective dog against trip lever 195 so that table may move on to one of its extreme end positions. In this way air is driven out when putting a new machine into service. Later on at an interruption of work this defect will be done away by simply traversing the table from one reversing point into the other one within a short way in applying power feed.

\*) for model BK 3 only.



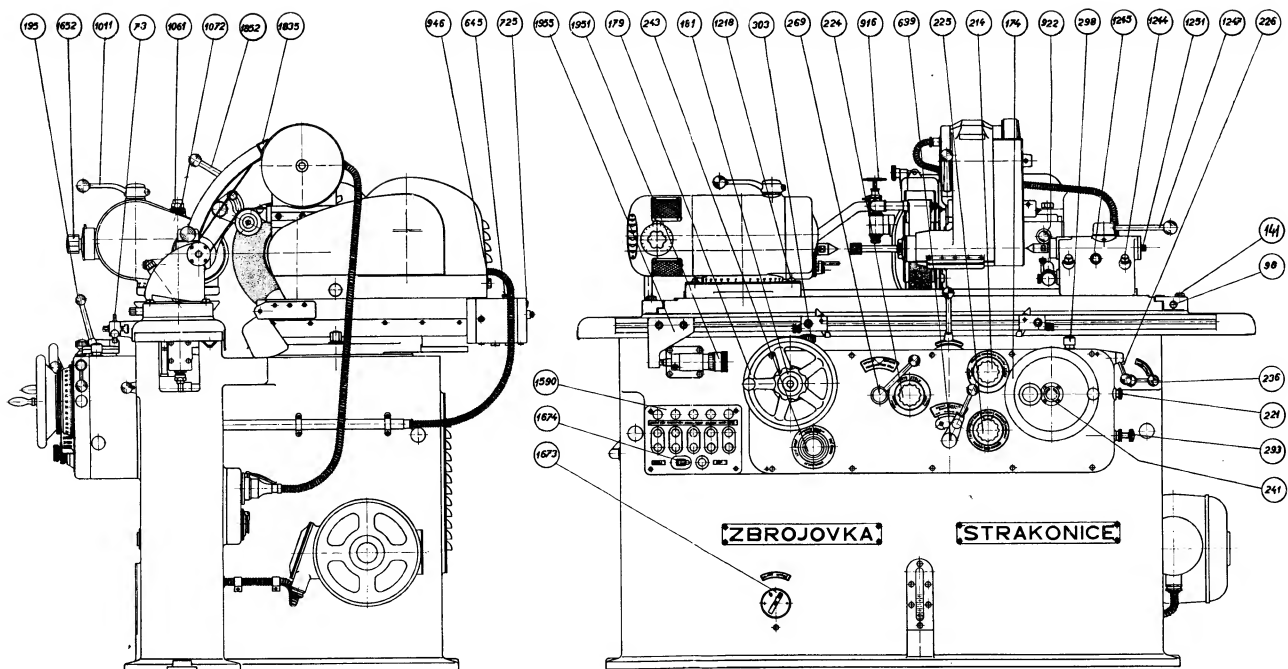


Fig. 3.

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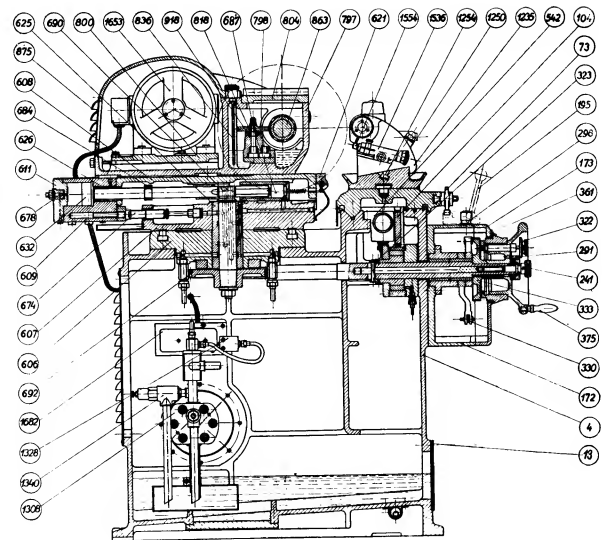


Fig. 4.

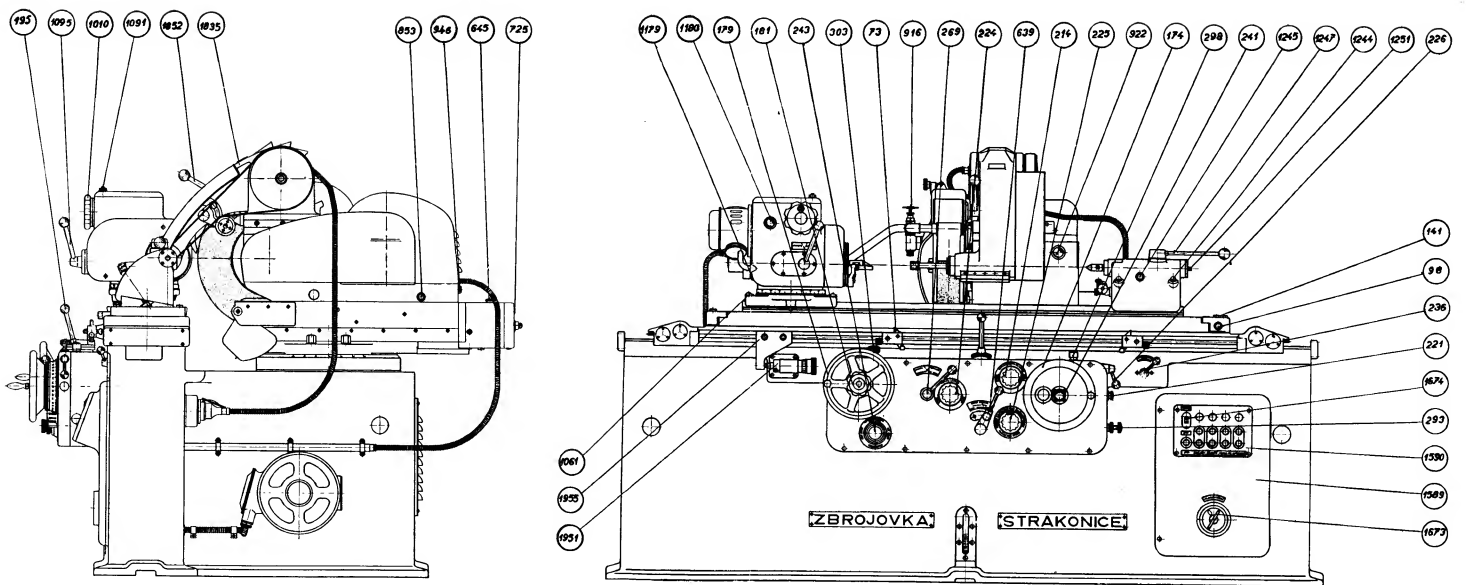


Fig. 3a.

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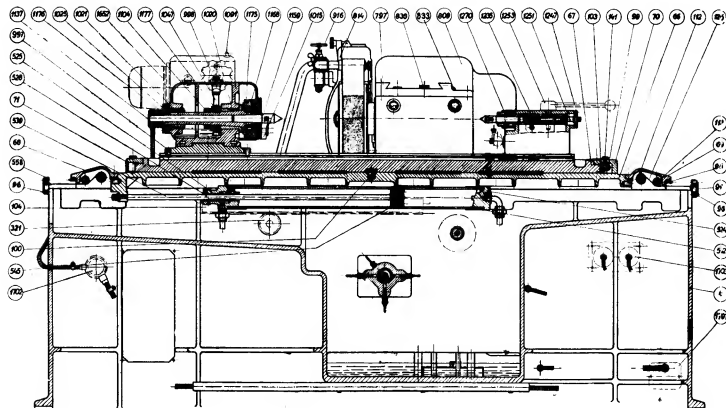
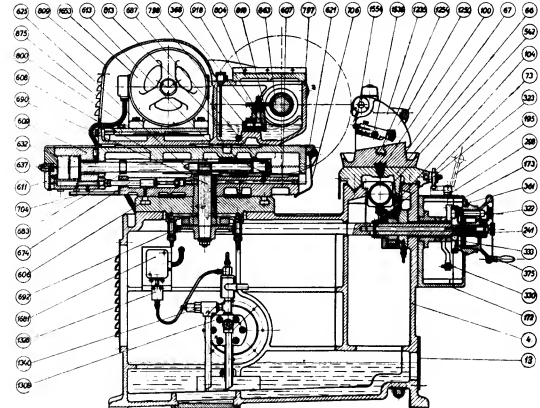


Fig. 4a.



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After traversing the table by hand to its end positions put on power feed and allow table to traverse several times from one end position to the other. Table speed, especially in end position, must not be too high to prevent damaging of cylinder 525 or piston rod 539 by heavy shocks. Change direction of table motion in its end positions by means of hand lever 195.

After making sure table motion is smooth, check power feed of wheel head in cut in reversing points and also independently on table motion.

Stop table travel by setting control lever 269 to "off" position. Check power feed of wheel slide in both directions by lever 639. In cylindrical grinding traverse slide 608 forwards. If, at grinding a work of larger diameter, slide will be backed up from work by hand, care is to be taken that the way for its rapid approach will be at least 40 mm (1 3/4"). If the wheel slide has been rapidly run back it must not be approached by handwheel 174.

Rotate grinding wheel several times by hand. Start motor for wheel spindle drive and observe oil gauge 922. Should no oil appear within a few seconds stop motor and remove defect in oil flow.

If the lubrication of wheel spindle works well, firstly rough true the wheel, then balance it together with its flange and finish truing. If the wheel spindle is now running true without vibrations, it is sufficiently balanced. If it is not the case, repeat truing and balancing until spindle runs perfectly true, without any vibrations.

(By means of handwheel on regulation motor 1652, (Fig. 3), set lowest speed of the work spindle driving motor and start this motor.\*)

Set by handwheel 1010, (fig. 3a), lowest motor speed for work spindle drive, start the motor and observe lubrication in gauge 1180 (fig. 3a). Work spindle speeds are set always after disengaging the clutch by clutch lever 1095. (Fig. 3a.)

Fill coolant tank and start coolant pump motor.

If there are no more defects and the machine runs without vibrations, it may be put into service.

In swivelling top table 67 for grinding tapers, loosen bolts 141 at both table ends and by turning screw 98 set table according to the scale to the required angle and secure it by tightening bolts 141.

Let the machine run loose, hydraulic drive being put on, for about 2—3 hours and observe the function of the individual machine parts.

At each setting-up of the machine the pressure pump has to run.

\*) for model BK 3 only.



## d) CONTROLS.

See fig. 3—4, 3a—4a.

- 73. Adjustable stop for limiting table travel.
- 98. Screw for swivelling the table.
- 141. Bolts for locking the table in position.
- 174. Hand wheel operating approach of wheel.
- 179. Hand wheel operating table traverse.
- 181. Hand wheel for setting fine table feed.
- 195. Table motion reversing lever.
- 214. Hand wheel for setting the speed of independent feed in cut.
- 221. Dead stop (to be pulled out when grinding against dead stop).
- 224. Hand wheel for setting the speed of hydraulic table feed.
- 225. Hand wheel for setting power feed in cut.
- 226. Lever for lifting the ratchet.
- 236. Lever to engage single-lever-operation.
- 241. Handwheel operating automatic run-back of wheel.
- 243. Hand wheel for stopping the table in reversing points.
- 269. Table motion control lever.
- 293. Screw for setting rate of feed in cut.
- 298. Push-button for fine adjustment of wheel by hand.
- 303. Hand wheel operating fine feed of table.
- 558. Nut of piston rod.
- 639. Lever actuating automatic withdrawal and approach of wheel slide.
- 645. Plug covering supply opening of oil tank in wheel slide.
- 725. Oil gauge indicating oil level in wheel slide oil tank.
- 833. Nut of wheelhead locking bolt.
- 838. Plug covering supply opening of oil tank in wheel head, connected with bar which indicates oil stand.
- 853. Screw for adjustment of wheel head on slide.\*\*)
- 916. Tap for stopping coolant supply.
- 922. Oil gauge (showing wheel spindle lubrication).
- 946. Screw for tensioning belts transmitting power to wheel spindle.
- 1010. Hand wheel for setting RPM. of work.\*\*)
- 1011. Lever operating work spindle clutch.\*)
- 1061. Nut of locking bolt to work headstock.
- 1072. Nut for tensioning belts of work spindle drive.\*)
- 1091. Locking pin for securing workhead in zero position.
- 1095. Workhead clutch lever.\*\*)
- 1179. Oil gauge showing oil stand in workhead.\*\*)

\*) for model BK 3 only.

\*\*) for model BK 5 only.

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## UNIVERSAL CYLINDRICAL GRINDING MACHINES Model BK 3, BK 5

29

- 1180. Oil gauge showing lubrication of work spindle bearings.\*\*)
- 1244. Nut of locking bolt to tailstock.
- 1245. Screw for securing tailstock spindle.
- 1247. Lever actuating tailstock spindle.
- 1251. Screw for adjusting the tension of tailstock spindle spring.
- 1589. Switch box cover (at the rear side of machine bed.\*\*)
- 1590. Push-button panel (operation of motors for the drive of wheel and work spindles as well as pressure and coolant pumps).
- 1652. Handwheel for setting the speed of workhead motor.\*)
- 1673. Main switch.
- 1674. Switch to spot light.
- 1702. Socket for coolant pump (to the left at the rear side of the machine).
- 1703. Socket for spot light (next to the socket for internal grinding).
- 1707. Terminal board.
- 1955. Dog to micrometric stop.

\*) for model BK 3 only.

\*\*) for model BK 5 only.

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## e) WORK HEADSTOCK.

## 1. Spindle Alignment, fig. 5 BK 3, fig. 5a BK 5.

Work spindle with driving motor 1652 are mounted in workhead casing 998. (Power is transmitted from motor shaft over cone clutch 1100 on driving pulley and therefrom by V—belts 1168 on pulley 1004 mounted in ball bearings 1175 on hub 1080 of work spindle 1025, fig. 5.)\*)

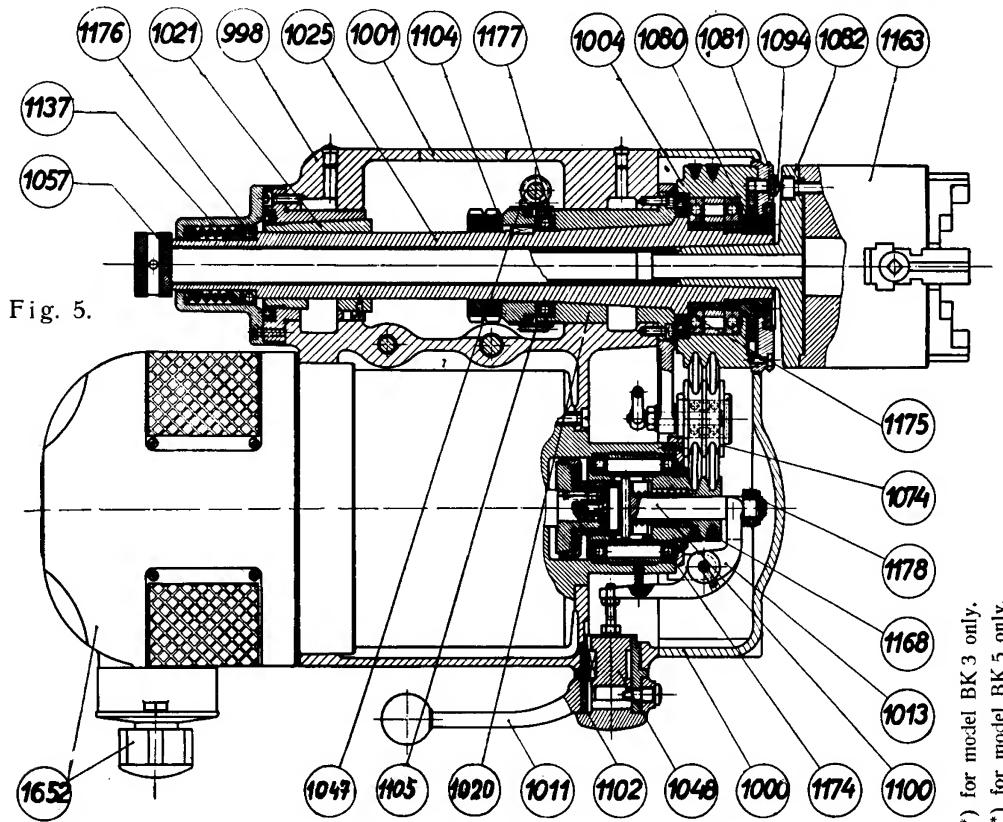
The driving power is transmitted from motor shaft over gear box to the driving pulley 1004 mounted in ball bearings on work spindle, (fig. 5a).\*\*)

Bearings 1020, 1021 of work spindle 1025 are properly adjusted at our work. Should the front bearing 1020 after some time call for compensation for play, nut 1104 under the cover 1001 is provided for this purpose. Nut 1104 has R. H. thread and after re-alignment of spindle it is to be secured by the locking nut. In compensating for play in front bearing 1020 the face of nut 1105 on model BK 3 must not contact face of distance ring.

Belts for spindle drive are tensioned by nut 1072, (fig. 3.). Belts are adequately tensioned at the factory. If, after a longer service, belts call for tensioning, proceed in the following way:

Loosen bolts of cover 1000 and remove same. Loosen securing nut of the screw of the tensioning roller feed rod and tension the belts by means of nut 1072. Tighten the securing nut. Tensioning of belts requires care because excessively tensioned belts are like to be damaged. (Fig. 5.) \*)

Belts for spindle drive on model BK 5 are tensioned by tensioning roller after removing the cover 1000, (Fig. 5a.)\*\*)





## 2. Grinding in Chuck, fig. 5, 5a.

In grinding in jaw-chuck or in collet-chuck arrange work headstock as shown in fig. 5, 5a. Loosen spindle by nut 1105 so that it will rotate freely in its bearings. A chart fixed at workhead indicates the direction of turning of screw 1047 for loosening the spindle.

Connect firmly flange 1081 with hub 1080 by means of bolt 1094. Bolt 1094 is to be put on the place of bolt 1059, (see fig. 6.). With the aid of tube 1057 inserted into the spindle replace centre 1159 (fig. 6.) by flange 1082 which is carrying chuck 1163.

After this provision done spindle rotates in bearings, pulley 1004 being firmly connected with spindle 1025. This procedure is applied in grinding holes or in grinding short cylindrical work of a small diameter, which is held in chuck.

To special order quick-acting chuck may be supplied for grinding large batches which considerably reduces the time necessary for chucking.

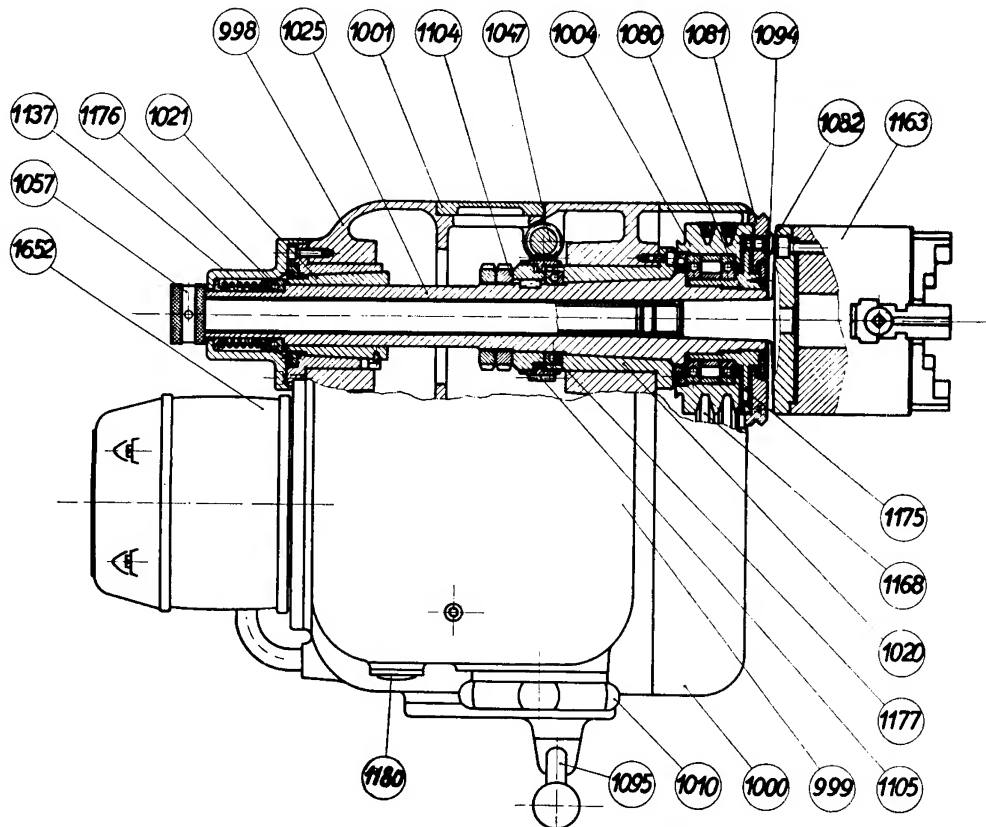


Fig. 5a.

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### 3. Grinding between Dead Centres, fig. 5, 5a and 6.

When grinding cylindrical work between dead centres arrange work spindle as shown in fig. 6. Mount driver 1015 on flange 1081 by means of bolt 1059. Mount centre 1159 in spindle by means of tube 1057. Spindle 1025 is to be secured by tightening nut 1105 on distance ring by means of screw 1047. In grinding only the pulley 1004 rotates being firmly connected with flange 1081 carrying driver 1015.

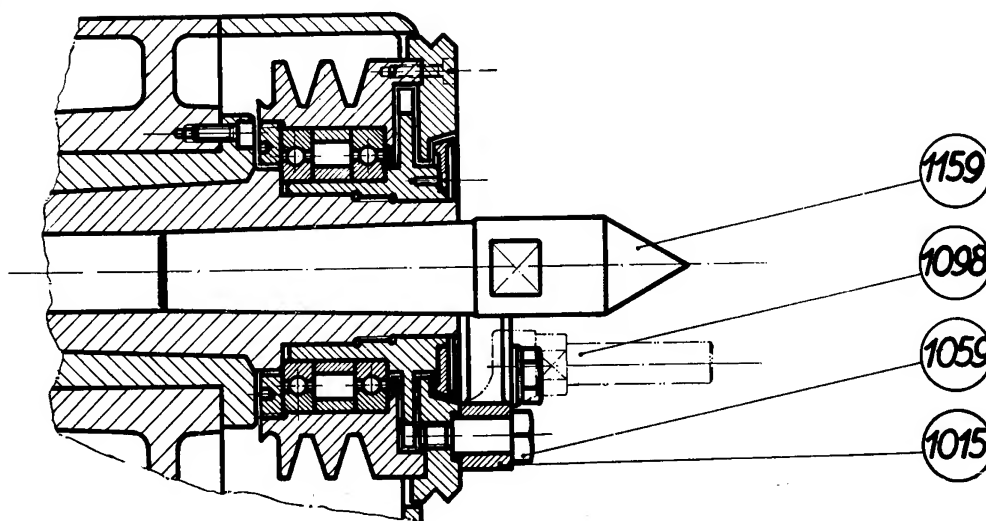


Fig. 6.

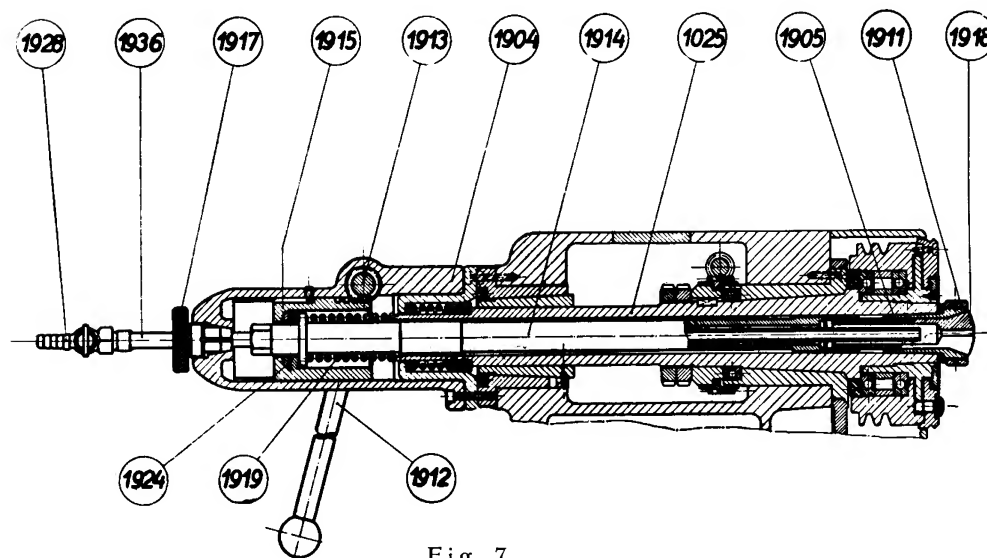


Fig. 7.

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#### 4. Quick Chucking, fig. 7.

For chucking work in collet 1918 use insertion 1905 which is to be put into the taper of spindle 1025. The insertion is extracted from spindle by nut 1911. The collet is clamped by tube 1914 leaning at the other end against spring 1919 the pressure of which holds work in collet 1918. For releasing the collet to dismount the work use lever 1912 with pinion 1913 mounted in holder 1904. Pinion mates with the toothing provided on sleeve 1515 resting with ball bearing against the collar of tube 1914. By setting lever 1912 to the right collet 1918 is released and work may be taken out. After inserting new work piece release lever 1912 and work will be automatically gripped by spring pressure.

Coolant is delivered through piping 1936.

#### f) WHEEL SPINDLE ALIGNMENT.

Fig. 8, 9.

Bearings 820 are accurately set at our works. Should it become necessary, after a longer service, to compensate for play, proceed as follows:

Dismount wheel 923 with flange and pulley 840 by means of dismounting device 1773, fig. 9. Nuts 844, 845 have L. H. thread, nuts 855, 857 858 and 859 have R. H. thread. Remove nut 855, remove bolts fixing the cover with axial bearings 919. Set axial play by nut 855. Clean cover 804, paint the contact area with packing compound and mount it on wheelhead body 797. Mount wheel and pulley.

#### g) PLUNGE CUT FEED SETTING.

Fig. 10, 11, 12.

Adjust the stop on index collar 334 of handwheel 174 so that at knocking of same against dead stop 221 the stationary zero mark will coincide with the zero mark on index collar as shown in fig. 12.

Index collar allows to be quickly turned by a greater number of divisions after having pulled by handwheel 322 the geared shaft 314 out of mesh with the inner toothing provided on index collar 334. If in mesh with shaft 314 index collar may be turned by a few divisions, only.

Let work diameter be by 0,05 mm greater than required, then turn index collar as shown in fig. 13. By turning the handwheel clockwise till the stop will knock against dead stop 221, grinding wheel will be fed in cut and work diameter reduced by 0,05 mm. Position of index collar after knocking of the stop against the dead stop is shown in fig. 12.

After the first setting accuracy attained on work pieces next in operation in plunge cut grinding against dead stop is within .0002" to .0004".

If power feed put off, lever 226, fig. 3, 3a has to point upwards. Should it be necessary to turn handwheel 174 anti-clockwise at automatic plunge cut grinding, lever 226 must be previously placed to point upwards.

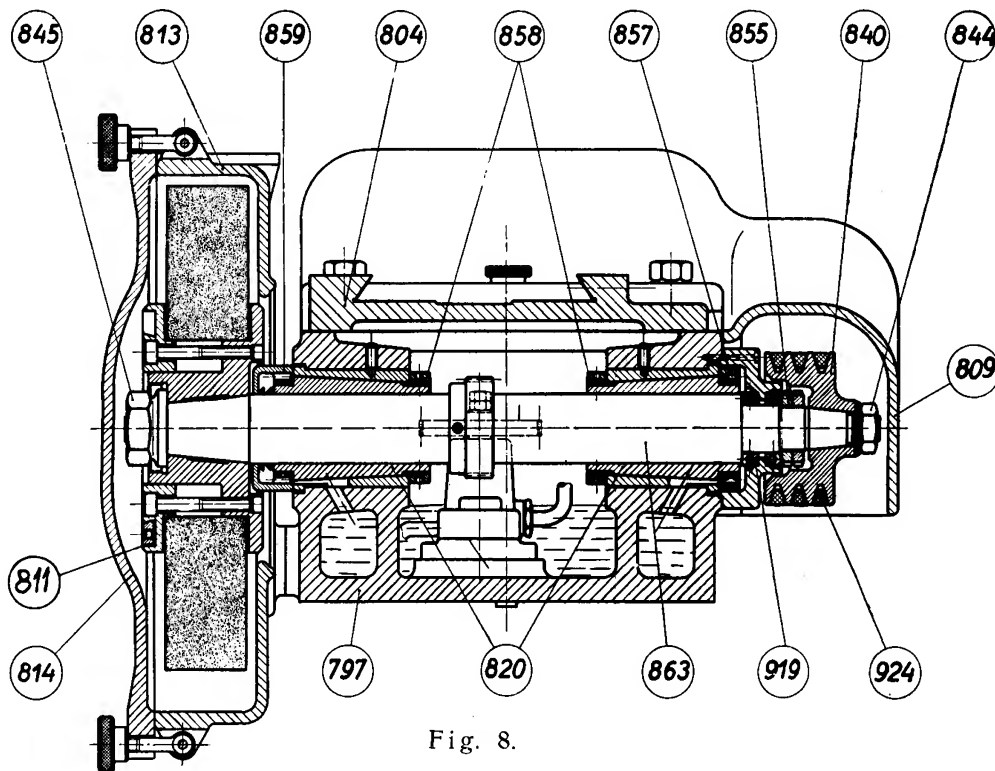


Fig. 8.

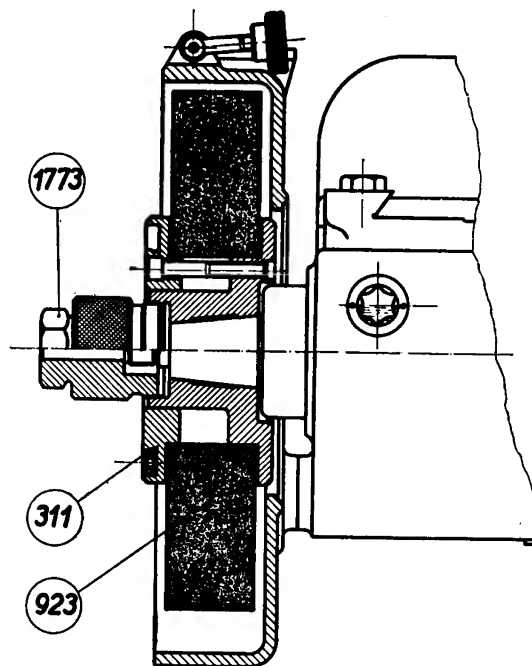


Fig. 9.

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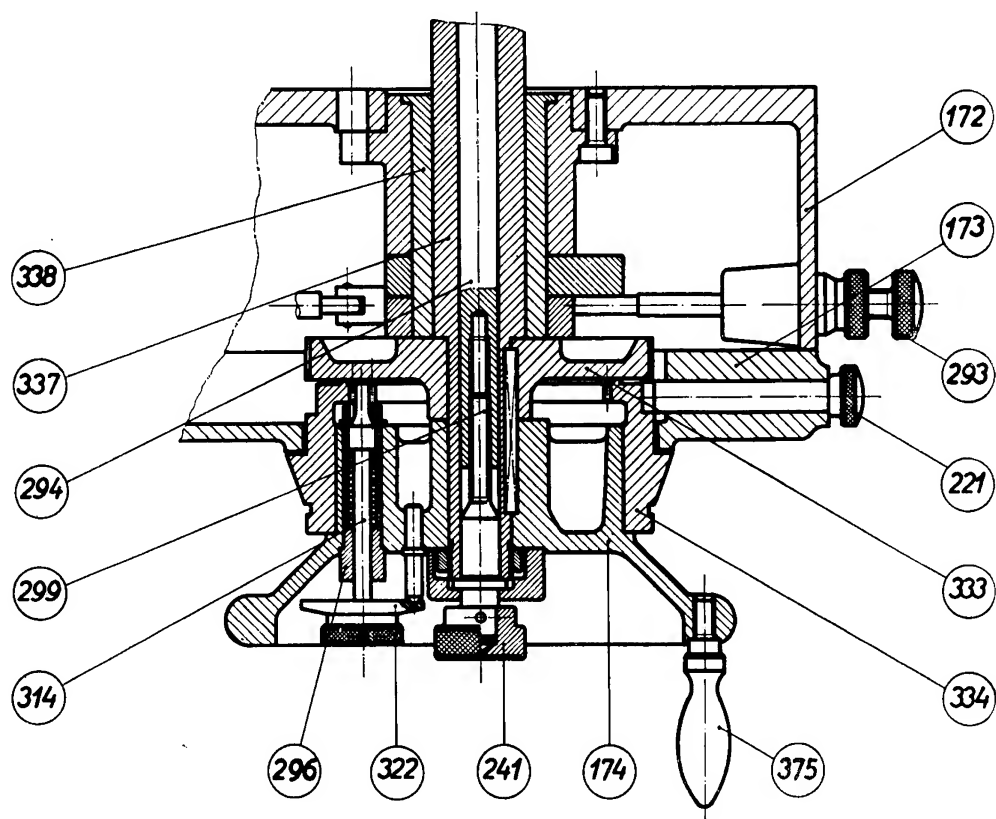


Fig. 10.

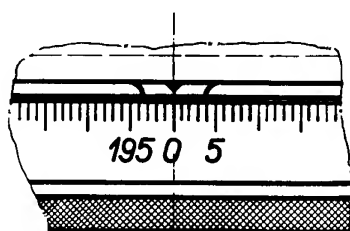


Fig. 11.

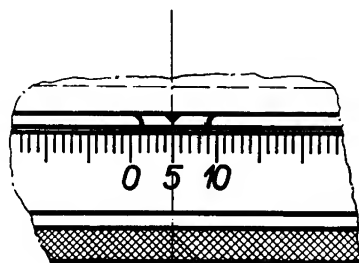


Fig. 12.

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#### h) HYDRAULIC CONTROL.

Fig. 13.

Pressure oil circuit is shown in fig. 13.

Oil is sucked from tank N by three pumps:

P 1 for table traverse,

P 2 for independent approach and rapid run-back of wheel,

P 3 for the cylinder for eliminating backlash in wheel slide gearing.

Oil pressure in piping may be adjusted for each individual pump by means of valves V1, V2 or V3, respectively.

Speed of table traverse is regulated by means of valve V4, speed of independent wheel feed by means of valve V5. The time for which the table has to dwell in reversing points is adjustable by valves V6.

By delivering pressure oil to the left side of regulator S1, the passage of pressure oil in piping 1 will be stopped and table motion interrupted.

At hand feed of table hydraulic table feed is put off by valve V7.

Regulator S2 is firstly actuated by table dogs over tripping lever P4 and rapid table traverse from one end position to the other is caused owing to the difference in oil pressures on unequal diameters of the regulator S2 from piping 2 or 3. Regulator S3 distributing pressure oil into pressure cylinder of table is actuated by oil pressure on regulator face. Pressure oil for this purpose is distributed by regulator S2.

The feed in left or right reversal is caused by delivery of pressure oil from regulator S3 through valve V8 to regulator S4 through piping 4, 5. Feed in both reversals as well as independent feed are actuated by regulators S5, S6 and valves V9, V10, V11.

Valve V12 operated by hand lever enables rapid approach and run-back of wheel by pressure oil led on right hand or left hand side, respectively, of piston 5.

Hand-operated valve V13 may be adjusted for stopping motors of work-head or coolant pump at rapid run-back of wheel and for starting them at rapid approach of the same. In this case pressure is developed on the right hand side of piston P7 and thus limit switch K is actuated.

Ring piston P8 actuates withdrawal of wheel by the amount of stock to be removed.

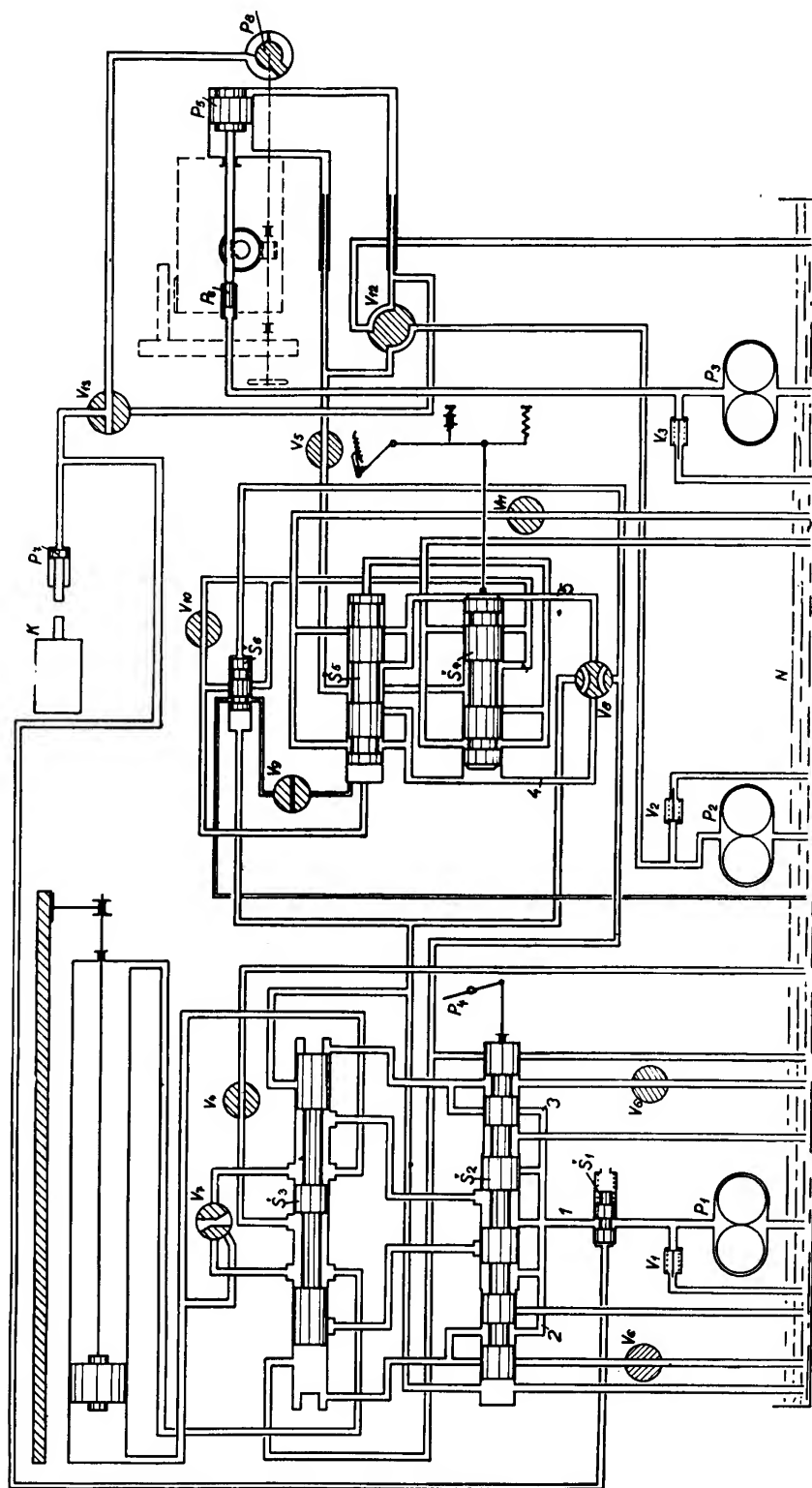


Fig. 13.

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### Electric Equipment for Standard Tension 380 V, 50 cycles

fig. 14—BK 3, 14a—BK 5.

- M1 — 1 electric motor (F 42 K 4\*) F 52 K/4 for wheel spindle drive.
- M2 — 1 electric motor F 51 K/8 for pressure pump drive.
- M3 — 1 electric motor CRN 4 for coolant pump drive.
- M4 — 1 electric motor F 22 K/4 for work spindle drive.\*\*)
- M4 — 1 regulation motor T 2022 E 4 for work spindle drive.\*)
- RTR — 1 Transformer NT 1500 for the regulation motor of workhead.
- S1 — 1 contactor VSc 25 with protecting relay RT — 11,5 (13,5) 7,5 (9,5)\* for wheelhead motor.
- S2 — 1 contactor VSc 15 with protecting relay RT 7,5 (9,5) for pressure pump motor.
- S3 — 1 contactor VSc 15 with protecting relay RT 0,65 (0,94) for coolant pump motor.
- S4 — 1 contactor VSc 15 with protecting relay RT 1,25 (1,75) 2,30 (4,20)\* for workhead motor.
- TZ — 3 (4\*) green, connecting push-buttons Ta 4 1/0.
- TC — 4 (5\*) red, disconnecting push-buttons Ta 4 0/1.
- Z — 3 (4\*) signal bulbs, E 10, 3, 5 V — 0,2 A.
- VH — 1 main switch VVD 25 — 31/3.
- VPV — 1 switch PL No. 456042 for workhead motor.\*\*)
- VS — 1 switch to spot light.
- KS — 1 limit switch PDa for automatic connecting and disconnecting of workhead motor and coolant pump motor.\*\*)
- KSV — 1 limit switch SRB KPVa 1/1 for automatic switching off workhead and coolant pump motors.\*)
- KSZ — 1 limit switch SRB KPVa 1/1 for automatic switching on workhead and coolant pump motors.\*)
- P1 — 3 fuses E 33 — 35 A.
- P2 — 1 fuse E 27 — 4 A for switch control circuit.
- Z1 — 1 socket 3+1 pole 15 A for coolant pump motor.
- Z3 — 1 socket 2+1 pole 10 A for spot light.
- ZT1 — 1 plug 3+1 pole 15 A for coolant pump motor.
- SV1 — 1 supply terminal board 4—pole up to 60 A.
- SV2 — 1 terminal board in series 24—pole up to 15 A.
- SV3 — 2 terminal boards in series 12—pole 6 A.

\*) for model BK 3 only.

\*\*) for model BK 5 only.

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The wiring diagram is completed for the case of connecting electric equipment for internal grinding which consists of:

M5 — 1 in-built electric motor (F2 — 19 K/2\*) F3 — 14 K/2.

S5 — 1 contactor VSc 15 with protecting relay 1,75 (2,30\*) RT 5,5 (7,5).

TZ — 1 green, connecting push—button Ta 4 1/0.

TC — 1 red, disconnecting push—button Ta 4 0/1.

Z — 1 bulb 3+1 pole 15 A.

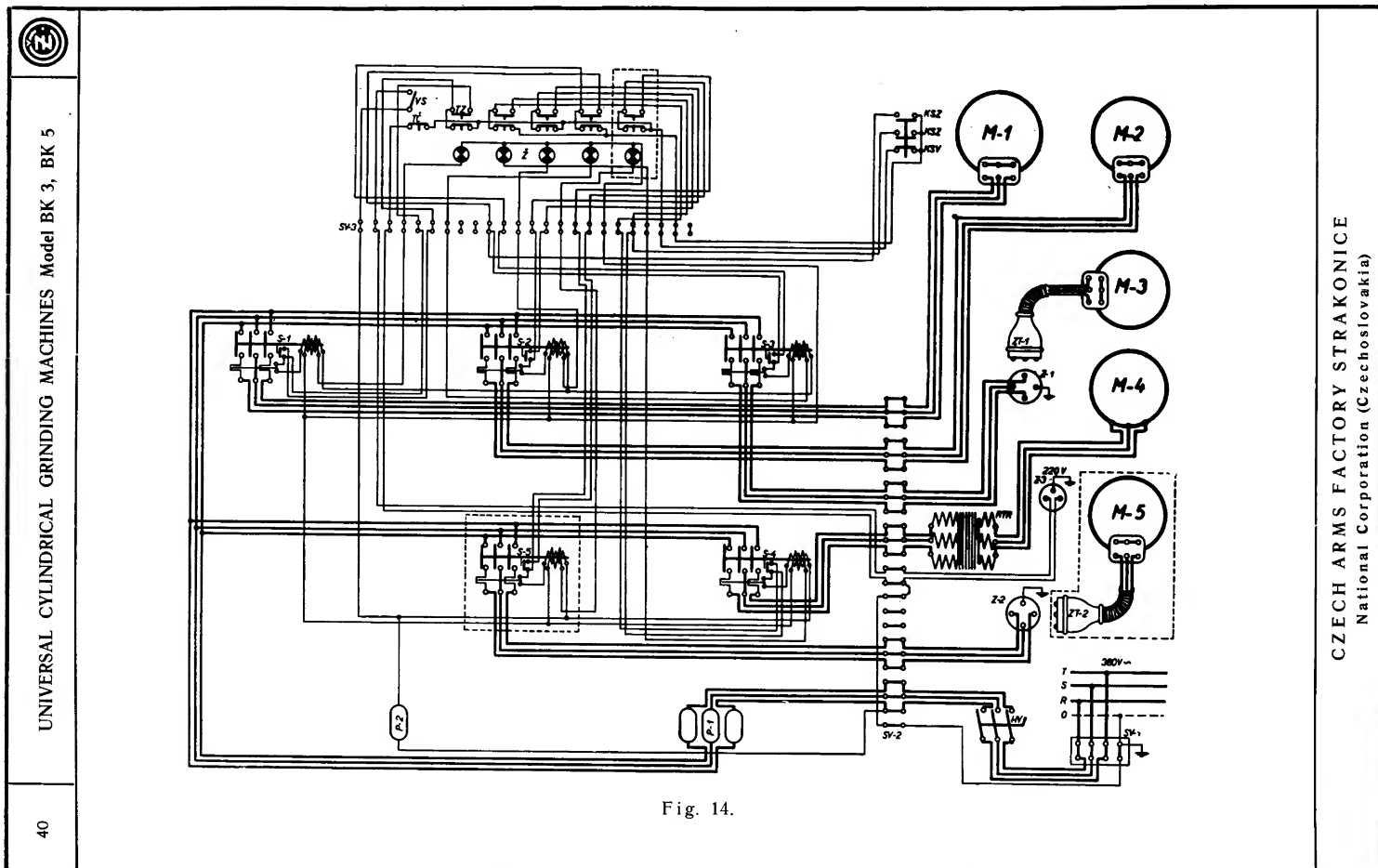
Z2 — 1 socket 3+1 pole 15 A for internal grinding.

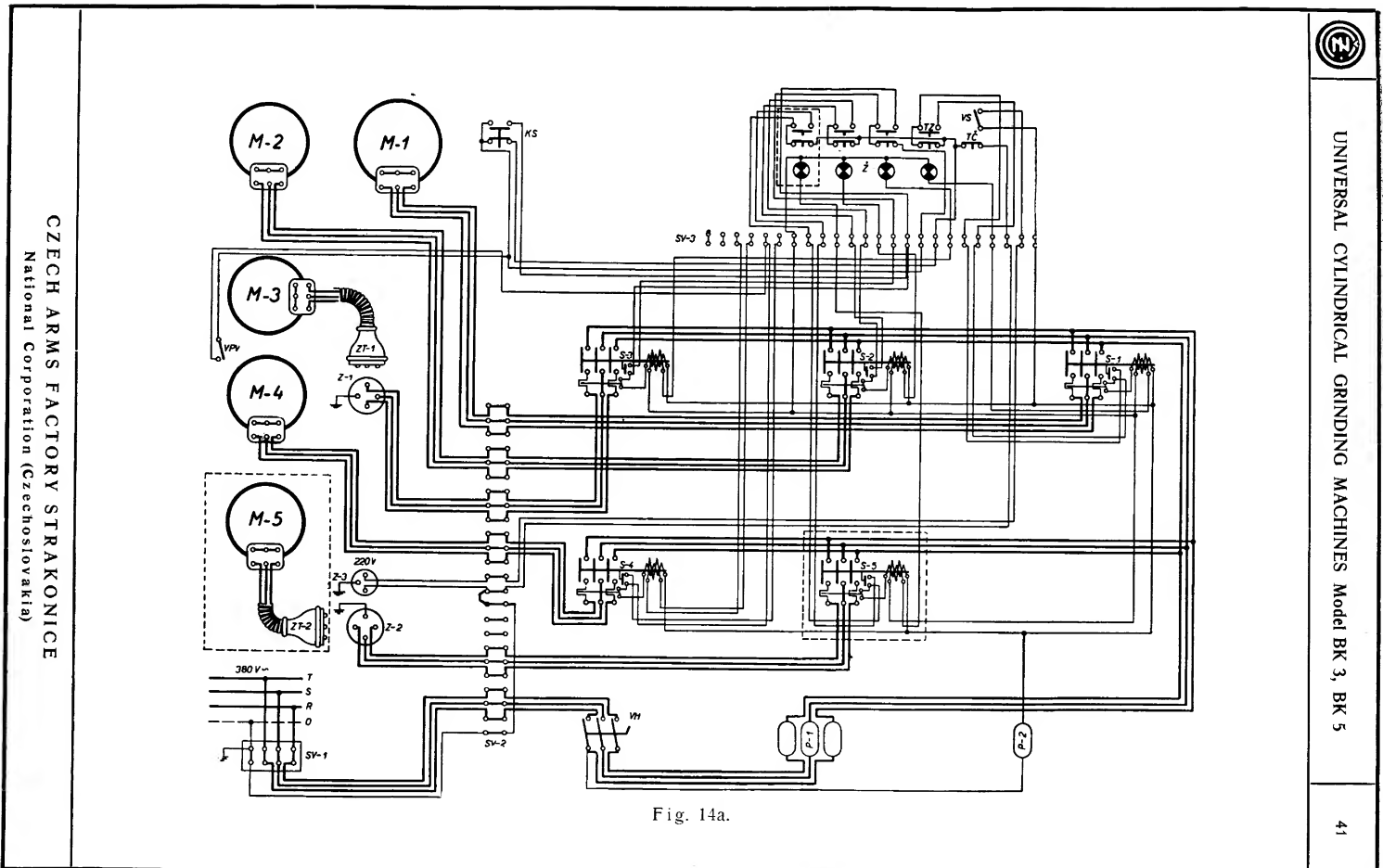
ZT2 — 1 plug 3+1 pole 15 A for internal grinding motor.

Following equipment is supplied standantly with each machine, except motor M5 and plug ZT 2 which are supplied only in connection with internal grinding attachment.

The values given in parenthesis at the protecting releases apply to voltage 220.

\*) for model BK 3 only.







## IV. LIST OF ANTI-FRICTION BEARINGS AND BELTS.

## a) Anti-friction bearings.

Group	Number of pieces applied	Manufacturers No.
Hydraulic unit	2 1	SKF 51102 SKF 51110
Tables**)	4	SKF EL 9
Wheel slide	2	SKF 51106
Wheelhead	1 2	SKF 6201 (SKF 51107)* SKF 51110
Workhead BK 3	2 2 2 1 1 1	SKF EL 9 SKF 16009 SKF 16012 SKF 51107 SKF 51110 SKF 51101
Workhead BK 5	2 5 2 2 1 1	SKF EL 9 SKF 6203 SKF 6204 SKF 10012 SKF 51107 SKF 51110
Pressure pump	1	SKF 6205
Internal grinding attacht.	2	SKF 16101
Quick chucking	1	SKF 51105

## b) Belts.

Group	Number of pieces applied	Manufacturer & Dimensions
Wheelhead BK 3	3	Bata 13×9 internal length 930 mm
Wheelhead BK 5	3	Bata 17×11 internal length 1200 mm
Workhead BK 3	2	Bata 10×7 internal length 600 mm
Workhead BK 5	2	Bata 13×9 internal length 705 mm
Internal grinding attachment BK 3	1	Woven belt 35×2×1175 mm
Internal grinding attachment BK 5	1	Woven belt 35×2×1415 mm

\*) for model BK 3 only.

\*\*) for model BK 5 only.

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### Lubricating points on Cylindrical Grinders BK 3, BK 5

The lubrication of these machines, as of all precision machines, requires special attention. The efficiency, safety in operation and long life of the BK Grinders depend to a great extent on the proper application of well chosen lubricants.

To facilitate your choice of lubricants we are giving the lubricants recommended by us in the below list.

Machine part	Way of lubrication	Lubricant recommended	Groupe	Note
workhead	wick (by hand*)	Gargoyle Vacuoline Oil C (Viscosity °E/50°C 2,5)	12	Keep oil level to oil gauge; renew oil each 3 months. (complete lubricant each 8 work. hours.*)
wheelhead	circulation	Gargoyle Vacuoline Oil C (Viscosity °E/50°C 2,5)	12	Keep oil level to oil gauge; renew oil each 3 months.
tailstock sleeve	by hand	Gargoyle Vacuoline Oil C (Viscosity °E/50°C 2,5)	12	complete lubricant each 8 work. hours.
table guide ways	oil bath	Gargoyle Oil Heavy Medium (Viscosity °E/50°C 4,9-5,2)	8	Keep oil level to oil gauge; renew oil each 3 months.
wheel slide guide ways	spraying	Gargoyle Oil Heavy Medium (Viscosity °E/50°C 4,9-5,2)	8	d t t o
hydraulic drive	pressure oil	Gargoyle Oil Heavy Medium (Viscosity °E/50°C 4,9-5,2)	8	Keep oil level to oil gauge; renew oil each sixmonth.
ball bearings	grease	Voco Grease BBK	22	Renew grease once a year.
Coolant	S/V Solvac Oil 100M Special		17	Emulsion with water 1:40 to 1:50.

**Important:** Keep oil level at the proper height. After first month of service drain all the oil containers and after having them cleaned fill in clean oil; renew oil fillings regularly as stated.  
Oil from hydraulic unit is to be drained each sixmonth; after having it filtered and completed it is to be refilled.

\*) for model BK 3 only.

J. STEINBRENER N. A., VIMPERK.  
Printed in Czechoslovakia.



**HINTS FOR GRINDING  
ON ČZ UNIVERSAL GRINDERS**

**BK 3, BK 5**

**CZECH ARMS FACTORY STRAKONICE**

**NATIONAL CORPORATION**

**(CZECHOSLOVAKIA)**



## **HINTS FOR GRINDING ON ČZ UNIVERSAL GRINDERS**

### **BK 3, BK 5**

To meet the wishes of our customers we have decided to issue this handbook, containing everything that an operator should know about grinding if he wants to utilise successfully all the advantages of our machines. It is an important supplement to the operating instructions of our universal grinders and will guide you in your work and in the removal of any faults which may occur.

#### **C o n t e n t s :**

- I. Methods of grinding.
- II. Selection of grinding wheel, its speed, balancing and dressing.
- III. Preparation of parts intended for grinding and allowances for grinding.
- IV. Speed of rotation of the part being ground, depth of cut and speed of table.
- V. Grinding with the help of steadies, chucking in the chuck and collets.
- VI. Cooling.
- VII. Hollow grinding.
- VIII. Various examples of grinding.
- IX. Grinding faults, their causes and remedies.
- X. Removal of any possible stoppages of the machine.

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## I. Methods of grinding.

**1. Longitudinal grinding** (see Fig. 1) is the most common method and is done by fixing the part between the centres or in any other way and moving it along a narrow grinding wheel. The stroke of the table is adjusted in a way allowing it to travel  $\frac{1}{3}$  of its own thickness beyond the edge of the part (see illustration!). Thick grinding wheels may also be used to advantage for longitudinal grinding using a quicker feed of the table which is particularly advisable when grinding hardened parts, where the cut depth has to be kept low to avoid excessive heating of the part.

The grinding wheel is fed into the cut at the end of the stroke of the table, either in one or in both dead centres. When the grinding operation is finished the part has to pass the grinding wheel several times without this feed (finishing).

If the part has a step at the end of the ground diameter the feed is done at that end of the stroke only. For this purpose the dwell in the dead centre may be used to advantage to cut thoroughly down to the adjusted depth at this spot.

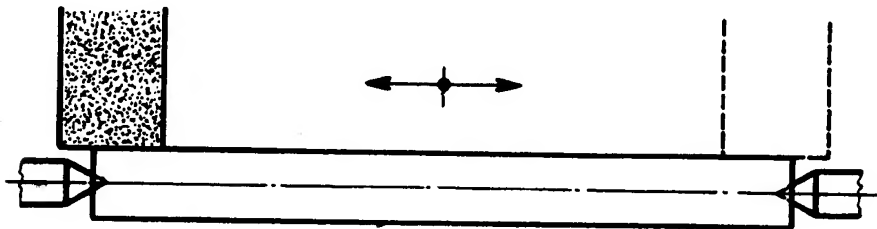


Fig. 1.

**2. Cut-in grinding** (see Fig. 2) is the latest and most important method of grinding and a grinding wheel is used for it at least as wide as the length of the ground diameter.

The grinding wheel is fed into the cut independently of the movement of the table and if the shape of the part allows, the table is given an oscillating movement which results in a faster and better cut.

If a grinding wheel of a width corresponding to the shape of the part cannot be fixed in the machine, the following procedure applies: the grinding wheel is moved into the cut close to the step with the table at rest until the required diameter is reached and then the table is fed lengthwise. The grinding wheel has to be tapered for the purpose (see Fig. 3).

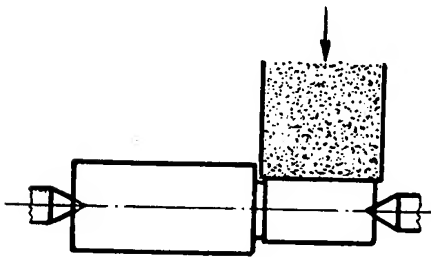


Fig. 2.

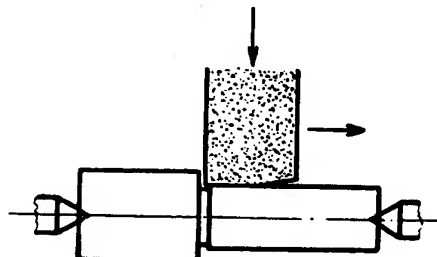


Fig. 3.

**3. Simultaneous cutting-in at several points** (see Fig. 4.) is a method giving the largest output in quantity production. When using this method it is essential to use slowly wearing grinding wheels and a convenient dressing attachment. The grinding wheels are built-up with the help of spacer rings on a flange as required by the shape of the part.

In case the ground diameters are close to one another (see Fig. 5) a wide grinding wheel may be used, dressed according to the shape of the part by means of a convenient form-dresser.



The great advantage of this method of grinding is that all the diameters are concentric and the shape of all parts identical, because of the fact that the part is fixed into the machine once only.

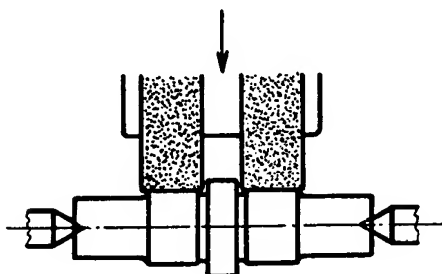


Fig. 4.

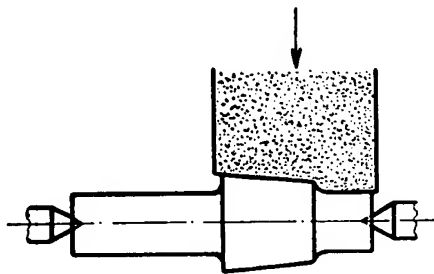


Fig. 5.

4. Multiple cutting-in side by side is used when a long part is ground by means of a wide grinding wheel (see Fig. 6). After the part has been roughed by the cutting-in method it has to be ground again to the required size by longitudinal grinding. For this method of grinding the machine has to be in perfect condition and the grinding wheel dressed strictly cylindrically.

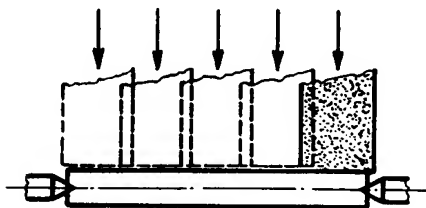


Fig. 6.

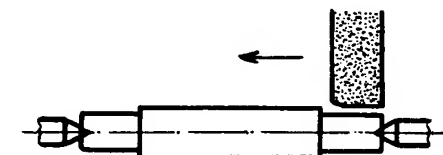


Fig. 7.

5. Grinding by means of a grinding wheel set-up to the required diameter (without any feed during the cutting operation) may be used when grinding short shafts and very thin parts without steps (see Fig. 7). To achieve good results it is essential to chamfer the leading edge of the grinding wheel and in case of thin parts to use a steady. It is not recommended to use this method when grinding hardened parts.

## II. Selection of grinding wheel, its speed, balancing and dressing.

1. **Selection of grinding wheel.** The selection of the grinding wheel is governed by a number of factors and it is therefore impossible to lay down a hard and fast rule, guaranteeing the best results. One of the conditions of successful grinding is that the grain of the wheel worn during grinding breaks away. Since hard material causes the grain to wear more quickly the following principles have to be observed when selecting a grinding wheel:

- 1) The harder the material of the ground part, the softer the wheel and vice versa.
- 2) For soft metals, which clog the wheel (brass, copper etc.) specially soft and coarse wheels with an open structure have to be used.
- 3) The larger the diameter of the part, the softer the wheel and vice versa.
- 4) The higher the peripheral speed of the part, the harder the wheel and vice versa.
- 5) Softer wheels for pipes to be used than for solid parts made of the same material.
- 6) Harder wheels to be used for broken surfaces than for plain ones.
- 7) The larger and wider the wheel, the softer it should be and vice versa.
- 8) When the same bonding material was used, a wheel with a finer grain works harder than with a coarser grain.



- 9) A slightly harder wheel works more softly and efficiently when its peripheral speed is reduced.
- 10) Generally speaking a softer wheel should be given preference over a hard one, as its output is higher and power consumption lower.
- 11) When cutting-in with the table at rest a softer wheel should be used than with the table moving. Form wheels, the edges of which should only wear slowly have to be a little harder than cylindrical wheels for the same material.
- 12) For hollow grinding softer wheels should be used than for surface grinding and for front grinding by means of a cup wheel a softer wheel with a more open structure than for plain round grinding.

The above principles apply to the „hardness“ of the wheel. The „grain“ is equally important. It is governed by the required quality of the cut. For roughing grain 36—46 is usually selected, which enables a deeper cut to be taken resulting in a higher output. Nevertheless it is necessary to take special care not to damage hardened parts by heavy roughing. A coarse grain may also temporarily be used for finishing when the wheel is especially finely dressed.

For roughing and finishing by single fixing a grain of 46—60 is recommended. It should be coarse for parts to which scale is sticking and finer for thin parts. A grain of 80—100 is suitable for finishing only and still finer grain for fine grinding. When using grain 100 or finer it is necessary to pre-grind with a coarser grain, because a fine grain does only allow a very thin cut to be taken. No less important is the „structure“ which expresses the ratio between grain, bonding material and pores in 1 cm<sup>3</sup> of the grinding wheel and has a certain influence on the results of grinding.

We are giving below a table intended as a guide for the selection of grinding wheels for various kinds of material and purposes. The kinds of grinding wheels listed in the table are products of the National Corporation Spojené závody na výrobu karborunda a elektritu v Benátkách nad Jizerou (United Carborundum and Electrite Factories in Benátky on Jizera).

	Method of grinding	Grain	Hardness	Structure	Kind of grinding wheel
Bronze hard	Round grinding	46	L	6	Electrite A
Bronze hard	Hollow grinding	60	J	6	Electrite 99
Aluminium	Round grinding	80	J	12	Elporite 99
Aluminium	Hollow grinding	46	J	8	Carborundum
Cast iron	Round grinding	36	J	5	Carborundum
Cast iron	Hollow grinding	36 — 46	J	5	Carborundum
Copper	Round grinding	46 — 60	L-K	5	Carborundum
Brass	Round grinding	36	K	5	Carborundum
Brass	Hollow grinding	36	J	6	Carborundum
Steel soft	Round grinding	46	N	6	Electrite A
Steel soft	Hollow grinding	46	L	5	Electrite 99
Steel hardened	Round grinding	46	L	5	Electrite 99
Steel hardened	Hollow grinding	60	K	6	Electrite 99
High speed steel	Round grinding	50	K	5	Electrite 99
High speed steel	Hollow grinding	46 — 60	J	6	Electrite 99
Nitrated steel	Round grinding before nitration	46	J	6	Electrite 99
Nitrated steel	Round grinding after nitration	60	J	8	Electrite 99

**2. Speed of the Grinding Wheel.** The most economical peripheral speeds of grinding wheels for grinding range from 25 - 35 m/sec. The drives of the grinding spindles of our machines are so designed that the peripheral speeds of new wheels are

BK 3 with wheel 350 mm dia. — 35 m/sec.

BK 5 with wheel 500 mm dia. — 30 m/sec.

Consequently they are still working with an economical peripheral speed after a considerable amount of wear.



In actual practice special cases may also occur requiring lower or higher peripheral speeds of grinding wheels. These requirements may easily be complied with by altering the ratio of the drive from the motor to the grinding spindle. The necessary diameter of the motor pulley may be calculated by means of the following formula:

$$d_1 = \frac{6000 \times v \times d_2}{3.14 \times n^{\text{mot}} \times D} \text{ where}$$

- $d_1$  = stands for the diameter of the motor pulley in mm
- $d_2$  = the diameter of the grinding spindle pulley in mm
- $D$  = the diameter of the grinding wheel in mm
- $v$  = the required peripheral speed of the grinding wheel in mm per sec.
- $n^{\text{mot}}$  = the speed of the motor in r. p. m. (1420 r. p. m. for grinders Types BK 3 and BK 5)

However we warn against the use of higher speeds than admitted by the manufacturing firm as marked on the label pasted to the grinding wheel.

**3. Balancing of the grinding wheel.** A perfect surface can only be obtained with a well balanced and dressed grinding wheel. For this purpose the flanges of grinding wheels are provided with balancing weights. The balancing is done on a balancing stand consisting of a support fitted with two rods shaped into edges, levelled perfectly by means of a circular spirit level fixed to the stand. The following procedure applies for balancing a new wheel:

The wheel, the hole of which has to correspond with the diameter of the centering collar of the flange, is set on the collar which has been previously fitted with a soft cardboard ring about 1—2 mm thick, the outside diameter of which corresponds with the diameter of the flange. An other cardboard ring is fitted on top of the wheel followed by the outside flange which has to be tightened uniformly.

Before starting to balance the wheel it has to be roughly dressed on its periphery as well as on its sides.

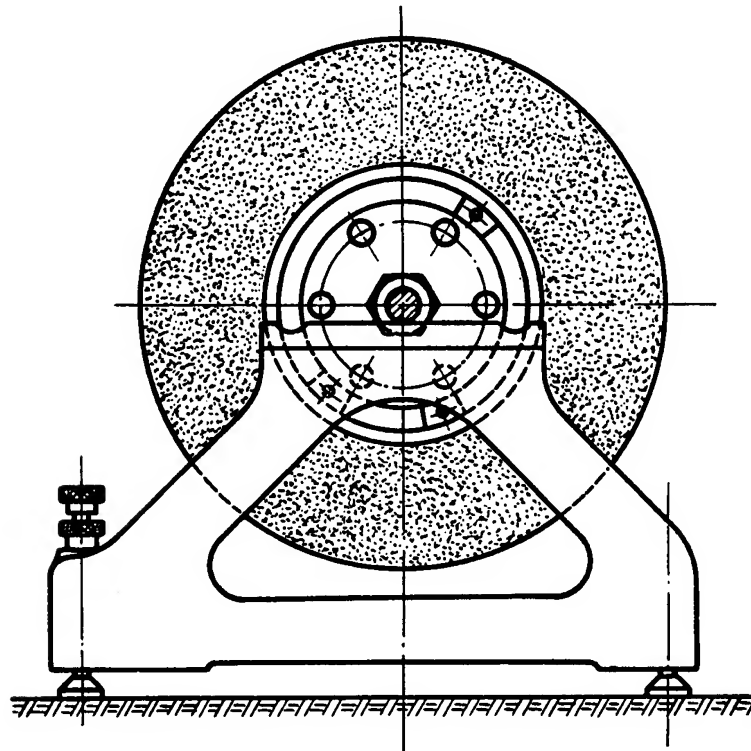


Fig. 8.

It is then removed from the spindle together with the flange and the balancing mandrel supplied with the machine is inserted in the flange, tightened and the whole is placed on the rods of the balancing stand as shown in fig. 8. The wheel rotates slowly in the direction in which it is drawn by the eccentric centre of



gravity „S“ and stops with this centre of gravity below the centre line (see fig. 9). Each one of the balancing weights acts upon the position of the centre of gravity on arm „a“. The centre of gravity is moved upward by moving the lowermost weights upward. The wheel is then moved slightly out of its position and allowed to come to rest once more. The lowermost weights are moved upward again and this operation is repeated until the wheel remains at rest in any position.

The flange with the wheel is then fitted to the spindle, dressed and removed again for re-balancing. After being fitted to the spindle once more the wheel is dressed for a third time whereupon it is ready for grinding.

**4. Dressing of the Grinding wheel.** The grinding wheel has to be dressed with particular care if a high output and accurate work is required. Star-wheels are used for rough dressing, a diamond dresser for fine dressing. The size of diamond is governed by the diameter of the grinding wheel.

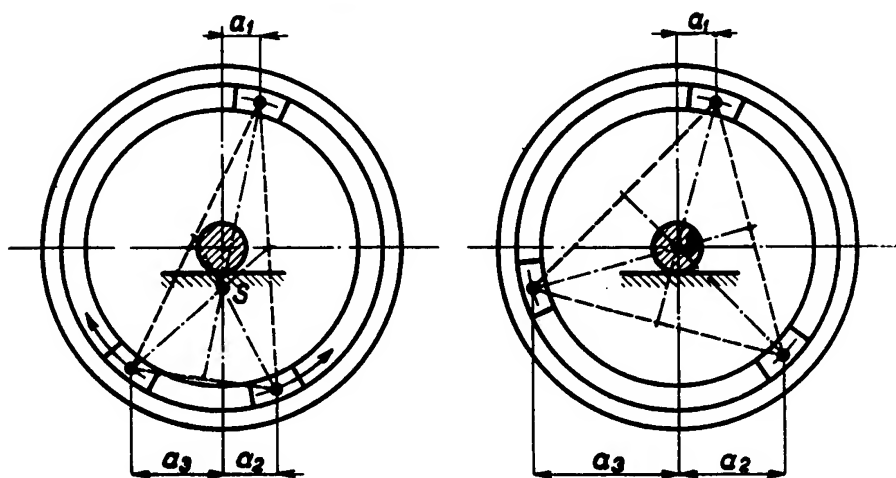


Fig. 9.

We recommend to use a 1 to 1½ carat diamond for our universal grinders Type BK 3 and BK 5.

The dressing attachment supplied with a stand is fixed on to the table of the machine. The arm with the diamond swivels and is fixed in its working position by an adjustable backing screw securing the position of the centre line of the diamond holder in relation to the centre line of the grinding wheel. There should be an angle of 3—5 degrees between the two centre lines (see fig. 10). A micrometer screw is provided for the exact adjustment of the diamond. The diamond is fed into the cut by moving the grinding slide. It is suggested, for the sake of a longer life of the diamond, not to take a deeper cut than 0.02 mm in one movement. A shallower cut should be chosen for soft wheels, with hard wheels one may go up to 0.05 mm.

**Speed of table when dressing:**

For roughing a higher speed and sharp diamond,

for fine grinding the smallest possible speed and a slightly blunted diamond. Dress the wheel principally under water and turn the diamond holder slightly from time to time, so as to dress the wheel always with a new edge! When grinding a larger number of parts (quantity grinding) adjust the diamond to the required diameter — in doing this you will save considerable time when dressing! On special order a whole range of special dressing attachments can be delivered, the most common of which are:

- a) Swivelling dressing attachment for dressing both sides of the grinding wheel; it can be used also for slanting the wheel to any required angle (necessary when working with an inclined wheel).
- b) Dressing attachment for rounding the edges of the grinding wheel with any radius (important for cut-in grinding where the ground diameter is connected to a step by a round profile etc.).
- c) Combined dressing attachment for dressing the wheel to obtain an outside radius (runways for bearing balls) or an inside radius (grinding of spherical shapes).



- d) Form dressing attachments, fitted on to the table of the machine, copying shapes according to patterns fixed on to the grinding spindlestock.

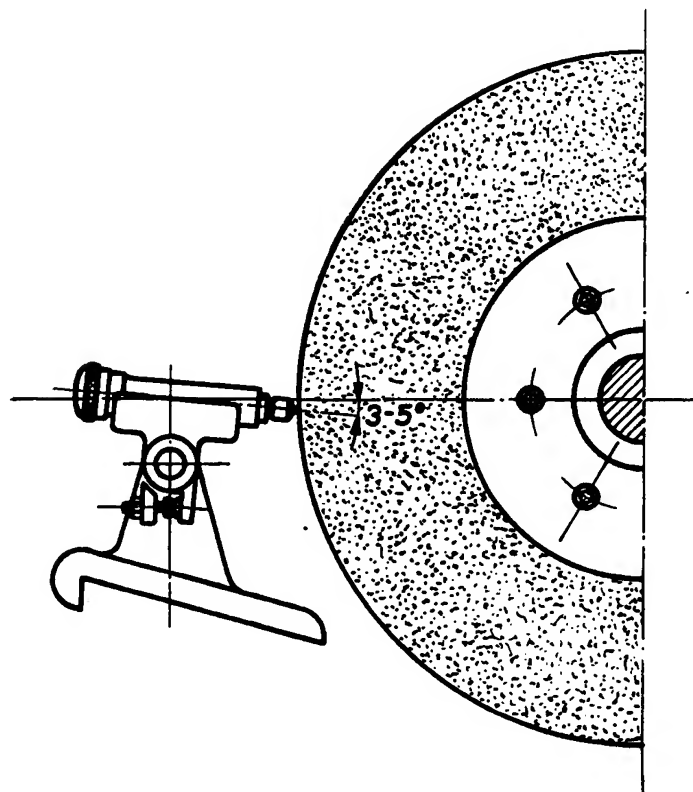


Fig. 10.

- e) Hydraulic dressing attachment, fixed on to the grinding spindlestock with automatic feed of diamond by any desired adjustable value, by which the difference of diameter caused by dressing the wheel is eliminated when working against a zero stop so that when quantity grinding, always the same diameter of ground parts is obtained without measuring (considerable saving of time).
- f) Hydraulic form dressing attachments, fitted on the grinding spindlestock, copying shapes according to patterns fitted on to the dressing attachment. The diamond is fed in the same way as when dressing according to para e). therefore also the advantages of quantity grinding remain the same.

### III. Preparation of Parts for Grinding and Allowances for Grinding Down.

**1. Preparation of parts.** To enable the operator not to lose time with frequent adjustments of table stops etc., it is essential to supply quantity parts for round grinding in identical lengths especially in case they have a step in their diameter. The corners should be made with special care, they have to be accurately round, smooth in the angle which has to correspond to the angle of the centres (normally 60°). For especially accurate work the corners are fitted with protective countersinks, preventing then damaging by shocks. The corners of hardened parts have to be ground on a special grinding machine for grinding corners or on a drilling machine in which a small grinding wheel has been chucked. The supporting centre of the machine must be exactly in the axis of the grinding wheel. As a makeshift the corners may be also ground by means of a cast iron tapered arbor, smeared with a mixture of emery and oil.

When help-stoppers with centring corners are used for centring hollow parts, these stoppers should be pressed in only slightly, because otherwise the ground



diameter would, after removing the stopper be smaller in view of the distension caused by the stopper. Parts with steps in their diameter if possible are fitted with cut-ins, which facilitates grinding in corners and allows oscillation of the table when cut-in grinding.

Broad, one-sided slots on thin parts are filled with hard wood, which is ground simultaneously with the part. By doing so the start-edge is pretacted from grinding down.

Hardened parts, still retaining remains of scale may advantageously be sanded before grinding. The grinding wheel is then not so easily filled up.

**2. Allowances for Grinding Down.** The allowance for grinding down depends on the following circumstances:

- a) Diameter and length of part.
- b) Shape of part (with steps or without, full or hollow shape).
- c) Quality of material.
- d) Heat treatment of the part.

Owing to the fact that no generally valid standards of allowances grinding down have been issued to date, we recommend to use the following table, giving tested and well-proved values.

Allowance for Shafts in Millimeters

Dia in mm over to		Allowance A from to		Allowance B length to mm from to			Allowance C length to mm from to		
1	3	0,08	0,10	50	0,08	0,15	50	0,15	0,25
3	6	0,10	0,13	100	0,10	0,20	100	0,20	0,30
6	10	0,12	0,15	150	0,15	0,25	150	0,25	0,40
10	18	0,15	0,19	250	0,15	0,30	250	0,30	0,45
18	30	0,15	0,20	400	0,15	0,35	400	0,35	0,50
30	50	0,20	0,25	600	0,20	0,40	600	0,40	0,60
50	80	0,20	0,26	600	0,25	0,45	600	0,45	0,70
80	120	0,25	0,32	600	0,30	0,55	600	0,50	0,80
120	180	0,25	0,33	800	0,30	0,60	800	0,55	0,90
180	250	0,30	0,40	800	0,30	0,60	800	0,60	1,00

**Allowance A** is always used, where the part is concentrically chucked by its diameter, having moreover an allowance for grinding (for instance a bush which is ground out- as well as inside).

**Allowance B** is used for not hardened objects up to the length mentioned in the table.

**Allowance C** is used for hardened parts with small deformations, further for tubes, parts with several steps and for soft parts being longer than admitted in column „B“.

## IV. Revolutions of Ground Part, Depth of Cut and Table Speed.

**1. Revolutions of ground part.** When selecting revolutions for the ground part, the following principles should be followed:

- a) When changing over on the ground part from one diameter to an other, the revolutions are changed in reverse proportion to the diameters i. e. when changing from a larger to a smaller one, the revolutions will be higher and vice versa.
- b) As the diameter of the wheel decreases, the revolutions of the part are reduced too, because the reduction of the circumferential speed of the wheel acts in the same way as when a softer wheel is used. Therefore it is also necessary to select lower revolutions of the part when only softer wheels than required by the work in question are at disposal.



- c) When only harder wheels than required by the work in question are at disposal, the revolutions have to be accelerated, because a slow run when grinding with a hard wheel has an unfavourable influence on the quality of the surface of the ground part.

Further we give you a guide-table for selecting circumferential speeds of parts for various materials and purposes according to the catalogue of Messrs. United Carborundum and Electrite Factories, National Corporation in Benátky on Jizera, as well as a table for determining revolutions under a given circumferential speed and diameter of ground part:

Circumferential Speeds in m/min.

Material	Round grinding		Internal grinding
	rough	fine	
steel weak	11 — 15	6 — 8	15 — 20
steel hardened	14 — 16	6 — 10	18 — 22
cast iron	12 — 15	6 — 10	18 — 22
brass, copper	18 — 20	14 — 16	28 — 32
aluminium	50 — 70	30 — 40	32 — 35

Approximate number of r. p. m. under a circumferential speed in m/min.

Ground dia in m	6	9	12	15	18	21	24	30	40
6	320	475	640	795	955	1115	—	—	—
8	240	360	480	598	720	840	960	—	—
10	190	285	380	478	570	665	760	—	—
15	125	190	255	319	380	446	510	640	850
20	95	140	190	239	285	334	380	480	640
25	75	115	153	191	230	268	305	385	515
30	65	95	127	159	190	223	255	320	425
35	55	80	109	136	165	191	220	270	360
40	48	70	96	120	143	167	191	240	320
45	43	63	85	106	127	148	170	212	290
50	38	57	77	96	115	134	153	192	256
60	32	48	64	80	96	111	128	160	214
70	28	40	55	68	82	96	109	136	181
80	24	35	48	60	72	84	96	120	160
90	21	32	42	53	64	75	85	106	141
100	19	28	38	48	57	67	76	95	126
110	17	26	35	43	52	61	70	85	113
130	—	22	29	38	44	51	59	76	101
150	—	19	25	32	38	45	51	65	86
180	—	16	21	27	32	38	42	56	75
200	—	13	19	24	27	33	38	48	64
250	—	—	15	19	23	27	31	40	53

**2. Depth of Cut.** The following principles are decisive for the depth of cut:

- The coarser the wheel is, the deeper the cut.
- When using fine wheels, shallow cuts should be adjusted because the wheel is easily filled up.
- Hardened parts require a shallow cut and a rapid feed (speed of table), also when using a coarse wheel. The same applies for slender parts.
- Notwithstanding the fact that large wheels allow deeper cuts, a shallow cut is recommended, because of the fact that the contacting surface is larger than when using small wheels, and the chip therefore longer.

For longitudinal grinding with feeding of the wheel in one or both dead centres of the table, it is recommended to use a feed of 0,005 to 0,05 mm when roughing, and 0,002 to 0,005 mm when fine grinding (we point out that these data concern the depth of single cuts, whereas the data divisions on the feed wheel of the grinding slides of our machines concern the decrease of the diameter of the ground part).





The following feeds are well-proved for cut-in grinding:

Dia. of part	Feed in mm per 1 revolution of ground part			
	Width of ground surface in mm			
	to 50	51 - 100	101 - 150	151 - 200
15 — 20	0,004	0,003	0,002	0,002
21 — 50	0,005	0,004	0,004	0,003
51 — 100	0,007	0,007	0,006	0,006
101 — 150	0,009	0,009	0,009	0,009
151 — 200	0,010	0,010	0,010	0,010

**3. Speed of Table.** The longitudinal feed of table per 1 revolution of the ground part is chosen as follows:

- a) when roughing  $\frac{2}{3}$  —  $\frac{3}{4}$  of width of wheel.
- b) when fine grinding  $\frac{1}{4}$  —  $\frac{1}{3}$  of width of wheel.
- c) when superfinishing  $\frac{1}{10}$  —  $\frac{1}{5}$  of width of wheel.

The shallower the depth of cut, the higher the speed of table and vice versa. A higher speed of table, when using a shallow cut, saves the wheel, and when grinding hardened parts there is no danger of damaging the material by overheating.

## V. Grinding by Means of Supports, Chucking by Chuck and in Collets.

**1. Using supports.** If we ascertain on ground surfaces of longer objects signs of vibrations, this is usually caused by not using supports or not using sufficient supports. It is therefore necessary to support the object correctly so that it may suffer no vibrations resulting from the pressure of the grinding wheel. For supporting objects ground on their surface, we use double-jaw supports. For supporting long objects ground inwardly we use triple-jaw supports. The jaws are adjusted by turning a milled button governing the respective jaw, which has to be done carefully to avoid bending the object by undesirable pressure of jaws. If the object has no suitable concentric surfaces for the supports it is necessary to obtain them by careful grinding. The table below indicates the recommended number of supports for a range of diameters and lengths of objects:

Diameter of ground objects in mm	Length between Centres						
	100	150	300	500	750	1000	1500
7—12	0—1	1	1—2	—	—	—	—
12—20	0—1	1	1—2	1—2	2—3	3	—
20—30	—	0—1	1	1—2	2—3	3	3—4
30—40	—	—	0—1	1	1—2	2—3	2—3
40—60	—	—	0—1	1	1—2	2—3	2—3
60—80	—	—	0—1	1	1	2	2—3
80—100	—	—	—	0—1	1	1—2	2
100—125	—	—	—	—	0—1	1	1—2
125—150	—	—	—	—	0—1	1	1—2
150—200	—	—	—	—	0—1	1	1—2
200—250	—	—	—	—	—	1	1—2

**2. Chucking by Chuck or in Collets.** Objects which cannot be ground between centres are chucked by chuck or in collets. The 3-jaw chuck supplied against special order is fitted with a flange with conical shaft by which the chuck is fitted into the working spindle (see drawing 5 and 5a of the operating instructions).

The attachment for rapid chucking in collets can also be supplied against special order and is fitted into the working spindle as described by drawing 7 of the operating instructions.

The mentioned systems of chucking are used almost exclusively for grinding wholes.



## VI. Cooling.

Cooling is applied as far as possible with every kind of grinding as well as dressing and it should be seen to, that the grinding wheel receives the current of cooling water along its complete width where it contacts with the ground object. The current of water should be sufficiently strong to absorb the heat resulting from the grinding.

Grinding wheels of a width of 100 mm require 60 to 80 litres of cooling water per minute. The water should always be clean as otherwise we should not achieve a cleanly ground surface. Therefore a sedimentation tank is used for cleaning the cooling water, in which the water separates from grinding wheel grains, metal chips and other impurities. The cooling water is mixed with 2—5 % soda as protection against rust, and for diminishing the friction between the grinding wheel and the ground object we add 1—2% of oil or grease of a kind which dissolves well in water.

The following mixture has proved suitable:

100 litres water, 2 kgs soda, 0,5 kg borax, 0,5 kg soft soap.

Since different places have varying degrees of water hardness, the composition of the cooling water should always be tested.

## VII. Grinding Holes.

**1. Choice of grinding spindle.** When selecting the grinding spindle it should be observed that the spindle or elongation be as short and strong as possible, because an excessive overhang of spindle or elongation causes vibrations or permits only

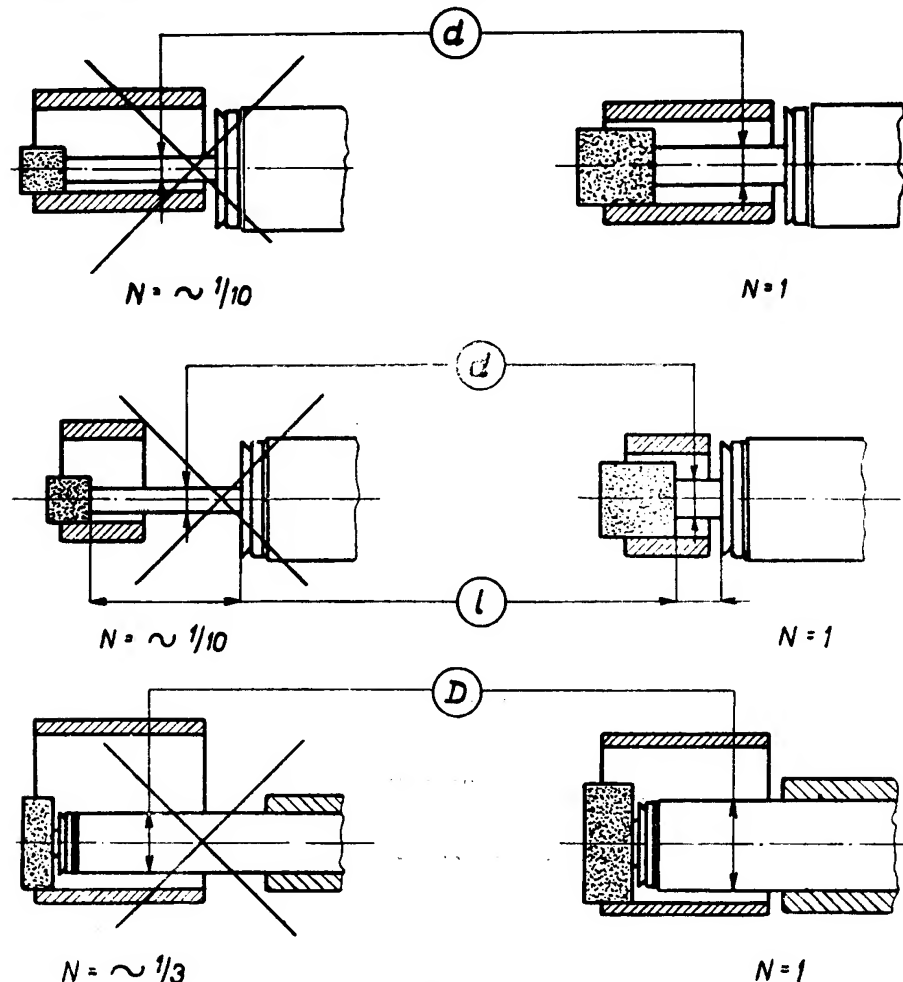


Fig. 11.

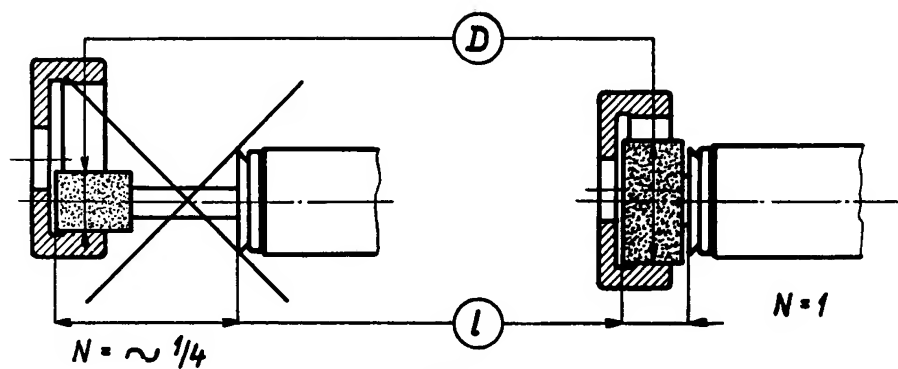


Fig. 11.

very shallow cuts, so that the output of the machine may very considerably decrease for reason of an unsuitable choice of spindle or elongation. The diameter of the grinding wheel should also be chosen as big as possible. This is best shown by drawing 11, giving side by side four examples of internal grinding with suitably and unsuitably chosen spindles, indicating the relative capacities.

Picture 12 shows spindles for internal grinding which we can currently supply with our grinders BK 3 and BK 5.

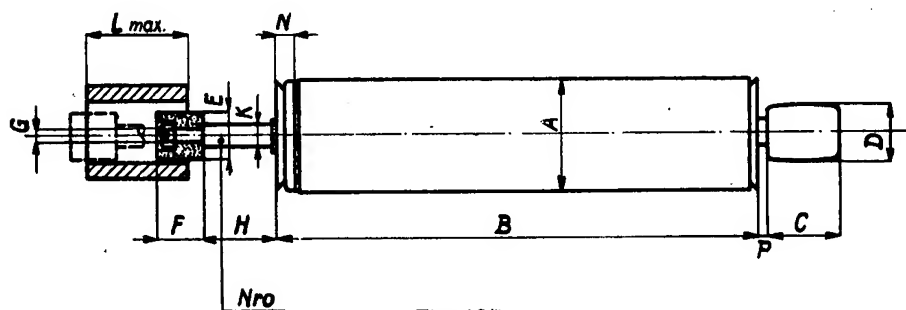


Fig. 12/I.

TYPE	n/min. max.	A	B	D	C	N	P	No.	K	H	L max.	E	F	G
V 70	15.000	70	260	40	45	11	7	1	8	30	40	15	15	5
								2	8	45	55	15	15	5
								3	10	30	40	20	20	6
								4	10	50	60	20	20	6
								5	13	40	55	25	25	8
								6	13	65	80	25	25	8
								7	18	95	105	30	30	10
								8	18	140	160	30	30	10

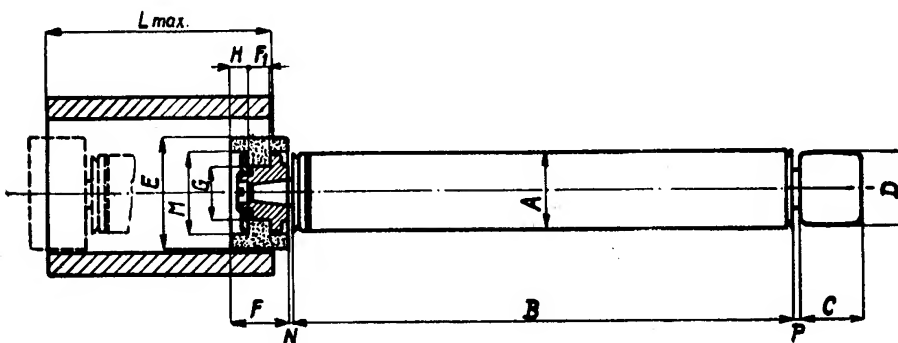


Fig. 12/II.



TYPE	n/min. max.	A	B	D	C	N	P	E	F	G	M	F <sub>1</sub>	H	L max.
Vk70x450	5.700	70	450	65	55	3	7	100-130	50	50	75	20	16	250
Vk70x650	4.000		650	90										450

**2. Choice of Grinding Wheel.** For grinding holes we usually use wheels which are somewhat softer than for surface grinding and their width should be as big as possible, enabling work under bigger table speeds.

The circumferential speed of the grinding wheels for internal grinding should be 20 — 25 m/sec. and the circumferential speed of the ground object should be chosen slightly higher than for external grinding, in order to balance the unfavourable influence of a big contact surface. The cooling should be very ample in order to drain reliably all loose particles resulting when grinding.

The table stops, when internal grinding, should be set so that the outer edge of the grinding wheel protrudes by approx.  $\frac{1}{3}$  of its width out of the hole; thereby you safeguard against enlarging the hole at the ends, which is apt to result from the increased surface pressure in the places where the grinding wheel contacts the ground part.

**3. Grinding-down Allowances.** For internal grinding it is more important to fix correct grinding-down allowances than for external grinding, because the permissible depth of cut is considerably smaller, so that the grinding-down of a certain allowance lasts considerably longer. It is therefore necessary to make that allowance as small as possible. The allowance however does not exclusively depend on the diameter and depth of the hole, but also on the heat treatment and manner of chucking.

When chucking in a 3-jaw chuck calculate for holes of medium diameters an allowance of 0,4 — 0,6 mm, but when using chucking collets an allowance of 0,2 — 0,3 mm is sufficient. For very small and long holes calculate allowances of 0,1 mm and less, this however requires accurately centered chucks and objects with a ground surface.

For currently fixing allowances for internal grinding, we recommend the following table, giving well tested values:

Diameter in mm over to		Allowance A from to		Allowance B length to mm from to			Allowance C length to mm from to		
3	6	0,08	0,11	15	0,08	0,15	15	0,15	0,25
6	10	0,10	0,13	25	0,10	0,20	25	0,20	0,30
10	18	0,10	0,15	40	0,15	0,25	40	0,25	0,35
18	30	0,15	0,20	50	0,15	0,30	50	0,30	0,45
30	50	0,15	0,20	70	0,20	0,35	70	0,35	0,50
50	80	0,20	0,26	90	0,20	0,40	90	0,40	0,60
80	120	0,20	0,27	120	0,20	0,45	120	0,45	0,70
120	180	0,25	0,33	150	0,25	0,50	150	0,50	0,80
180	250	0,25	0,35	180	0,25	0,55	180	0,55	0,90

**Allowance A** to be used for objects having a machined surface which is concentric with the hole and which can be chucked in an accurately centered chuck.

**Allowance B** to be used for objects which are not hardened, having a surface which is not entirely concentric with the hole and which are chucked in an accurately centered chuck. The same values are applicable for hardened parts when their length does not exceed the data of the present table.



**Allowance C** to be used for not hardened objects chucked in a 3-jaw chuck as well as for objects which are hardened but longer than permissible under column „B“, provided they are chucked in accurately centered chucks.

**4. Dressing.** For dressing the grinding wheel we use dressing attachments as described under para II/3, as far as they are suitable for this purpose.

## VIII. Various Examples of Grinding.

In the following we describe several cases of grinding, giving details beginning with the correct choice of allowances for grinding-down up to completing the work, with detailed instructions concerning the sequence of operations so that an unexperienced operator could correctly handle our machines.

### Example 1:

We are to grind a shaft as shown in drawing 13, made of material St 70. 11.

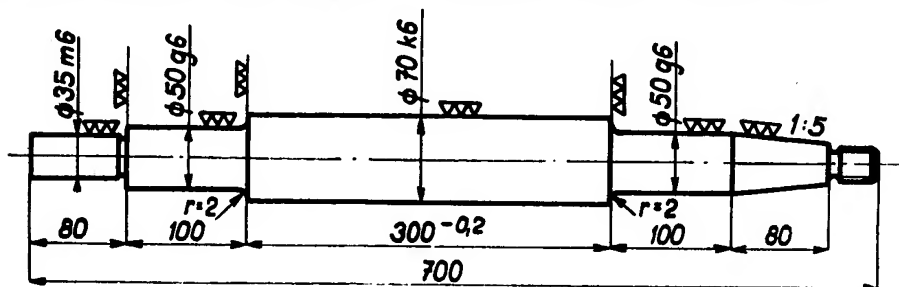


Fig. 13.

**Allowance for grinding-down** to be chosen according to table in para III/2 i. e. in our case according to column „C“.

For the diameters 70 and 50 we add an allowance of 0,5 mm, for the diameter 35 and the cone an allowance of 0,4 mm will be sufficient because in the proximity of the centres shaking is less likely.

**The choice of grinding wheel** should be made according to the table in para II/1, giving for mild steel a grinding wheel of Electrit A, grain 46, hardness N and structure 6.

**Circumferential speed.** If we have a new grinding wheel of a dia. of 350 mm, the circumferential speed for the grinder BK 3 is 35 mm/sec. The grinding wheel is fitted to the flange and balanced as described in para II/3.

The preparation of the working-spindle-stock for centre grinding is done according to drawing 6 and the respective description in the operating instructions. We then move the tailstock so far in the direction of the working-spindle-stock that the length of the shaft (700 mm) can pass between both centres when we withdraw the tailstock sleeve by lever 1247 (see the operating instructions), and then we firmly tighten the tailstock by means of the screws 1244.

According to the table in para V/1, it is recommended to use a steady rest for objects of dia. of 70 mm and a length of 750 mm. We set it up in the middle between both centres, however draw the jaws back.

How to bring the machine into operating condition is described in detail in the operating instructions. We therefore now proceed to describe the further sequence of operations:

We start the motor of the pressure pump by pressing the green button under the label „Hydraulics“. By operating the hand wheel 174 we adjust the table so that the grinding wheel is placed between the centre of the working spindle and the centre of the tailstock and then, by turning lever 639 to the right, effect the approach of the grinding slides with the grinding wheel forwards. By turning hand wheel 174 we adjust the position of the grinding wheel so that its distance from the axis of the centres is bigger than half the diameter of the shaft in its strongest place. (Before turning the hand wheel, lift the feeding pawl out of engagement by turning handle 226 forwards). Turning the lever 639 to the left effects the reverse of the grinding slides backwards.

We now fit the carrier to the cylindrical end of the shaft, inspect the corners, clean them carefully, oil them or apply vaseline or thick oil and insert same



between the centres. Then we check whether the shaft revolves without resistance and secure the tailstock sleeve by means of screw 1245. Finally we adjust the position of the carrier 1098 so that the shaft is correctly carried by the revolving working spindle.

Then we bring the grinding wheel forward and by turning hand wheel 174 adjust the table so that f. i. the left edge of the grinding wheel overlaps by approx.  $\frac{1}{3}$  of its proper width the left end of the 70 mm strong part of the shaft and shift the left table-stop to the lever 195 which we move to the right and then fix the stop. Now we move the table so far to the left that the right edge overlaps by approx.  $\frac{1}{3}$  of its proper width the right end of the 70 mm strong part of the shaft and shift the right table-stop to the lever 195 which we move to the left and then fix the stop (see dwg. 14).

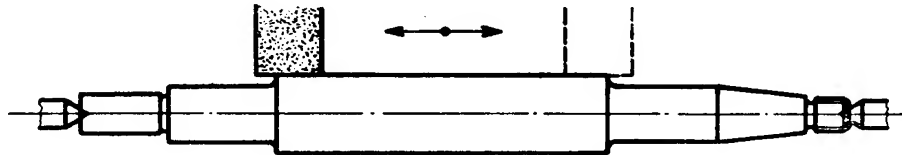


Fig. 14.

Herewith the setting of the table stroke is completed so that we can put it into operation by turning lever 269 to the right. The table speed is adjusted by turning the button 224 and for the roughing it should be  $\frac{2}{3}$ — $\frac{3}{4}$  of the width of the grinding wheel per one revolution of the shaft (see para IV/3).

The motor of the working spindle is started by means of the green press-button under the label „Working-Spindle-Stock“ (on the BK 5, by turning the lever 1095), and by turning the wheel 1652 we adjust the desired revolutions (on the grinder BK 5, by turning the wheel 1010 which has to be done before starting the motor). If some position cannot be adjusted without overcoming resistance, we start the motor for a second. The required speed is ascertained according to table in para IV/1 which gives for roughing mild steel: 11—15 m/min. (We chose 12 m/min.) and in the further table, for diameter 70 mm, we find the required number of revolutions: 55/min.

Now we start the motor of the grinding-spindle-stock by means of the green press button under the label „Grinding-spindle-stock“, while watching the oil gauges, to see whether the lubrication of the spindle functions correctly. If the lubrication is in order, we approach slowly, by turning hand wheel 174 to the right, to the shaft and the moment we see the first sparks we open up the cooling water supply 916. The spout in front of the grinding wheel cover should be set in a way that the current of water should aim at the place where the grinding wheel and the shaft contact.

By feeding the grinding wheel into cut by hand wheel 174 in the dead centre table positions by 1 section (turning to the right) we grind the shaft down sufficiently to eliminate all traces of machining by lathe. We then recede with the grinding wheel (lever 639), stop the table movement by turning lever 269 to the left and the spindle by drawing lever 1011 towards self (on the BK 5 we stop the spindle by turning lever 1095 to the left).

Now we measure the shaft with a micrometer on both ends, to ascertain whether the machine grinds truly cylindrically. If the shaft is f. i. thicker on the right side, we loosen screws 141, securing the table and turn the screw 98 slightly to the left, correcting the deviation and then again tighten the screws. Then we put the table and the spindle into motion, bring the grinding wheel forwards and grind-off a further cut. Then we measure the shaft again and if necessary effect a further correction which is to be continued until we obtain the correct measure on both ends of the shaft.

We now feed the grinding wheel in each dead end position of the table into cut (by means of hand wheel 174), by the value determined by para IV/2, recommending for roughing a feed of 0,005 to 0,05. We chose 0,02 which means that we advance the hand wheel 174 in each dead end position by four segments to the right. The allowance for grinding-down is 0,5 mm. For fine grinding we retain an allowance of 0,1 mm so that the roughing would be completed after 10 traverses of the grinding wheel (40 segments calculated with the adjustment of the cylindrical shape).



Thereafter the grinding wheel is withdrawn and the table and spindle movements stopped. We measure the exact diameter and by turning button 322 (drawing 10 of the operating instructions) we turn the dial 334 of the feed wheel on to the value by which the measured diameter is larger than the nominal dimension which should be  $(70 \pm 6) 70,02$  mm. If for instance measurement revealed 70,14 showing that the present diameter was by 0,12 stronger than the nominal one, the grinding wheel should be set to segment „12“.

Now we carefully tighten the jaws of the steady to the shaft and commence with the fine grinding. The table speed should be modified as per para IV/3 to equal  $\frac{1}{4} - \frac{1}{3}$  of the grinding wheel width per one revolution of the shaft, the number of revolutions according to the tables in para IV/1 to 6—8 m/min., i. e. approx. 35 r. p. m. for a diameter of 70 mm and finally the feed into cut according to para IV/2 to 0,005 mm, i. e. 1 segment in every dead end. The steady jaws should constantly be carefully tightened. After the dial arrives at zero point, we let the shaft pass a few more times along the grinding wheel without feeding into cut (to complete the sparking) and then we withdraw the grinding wheel and stop the table and spindle movements.

If we find the ground diameter to be correct, we remove the shaft from between the centres, shift the steady aside and fix the dresser on to the table for rounding the edges.

The stop for adjusting the diamond is fixed on the second segment from zero ( $r=2$ ) to the right, then tightened and the setting of the diamond effected according to the stop. The stop is now withdrawn and the dresser turned to the right as if we intended to dress the right side of the grinding wheel.

Now the grinding wheel is brought forward and the table position adjusted so that the diamond is on the right side of the wheel and then we range the fine table feed by manipulating the handwheel 181. By turning the button 307 to the left we slowly approach the grinding wheel until the diamond touches it and by turning the handwheel 174 we dress the right side of the grinding wheel (the dressing is effected under cooling water). Then we turn the dresser into the center position in which we secure it by means of the respective screw and turn the button 307 four times to the right (one turning equals 0,5 mm), whereupon we slowly approach the grinding wheel to the diamond. As the diamond touches the wheel, we release the turning arm of the dresser and by slowly turning to the right we round the edge of the grinding wheel to the adjusted diameter (a larger diameter must be preliminarily roughed).

After rounding the right edge of the grinding wheel we withdraw it by turning the handwheel 174 to a distance bigger than one half of the diameter of the shaft and by turning lever 639 to the left we remove the grinding slides backwards. Then we detach the dresser, approach the steady and insert the shaft again between the centres and carefully tighten the jaws of the steady.

Now we release the wheel 181 of the fine table feed and set the table for grinding the left step of the shaft of a diameter of 50 mm (see drawing 14). We bring the grinding wheel forward and by hand wheel 174 feed the wheel into cut. As soon as the traces of machining disappear where the shaft was ground, we withdraw the grinding wheel and measure the ground diameter (we find for instance  $50,32$  mm) and fix the difference between the measured and nominal diameter ( $50,6 - 49,99$ ), which in the present case amounts to 0,33 mm and this value is set on dial 334. Then we again bring the grinding wheel forward and feed it by turning the hand wheel by one segment per revolution of shaft into cut until reaching zero.

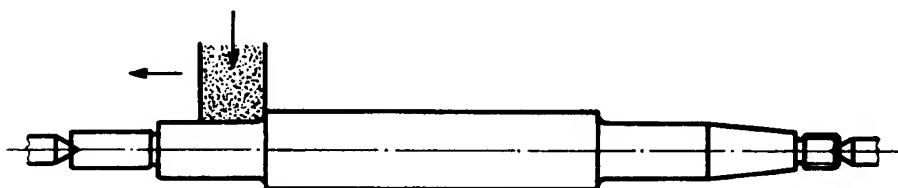


Fig. 15.

We very carefully turn the hand wheel 179 to the left until the right side of the grinding wheel grinds the left front surface of the large diameter of the shaft, then slowly turn the hand wheel to the right until the left side of the grinding wheel



reaches by approximately  $\frac{1}{3}$  of its width over the left edge of the ground diameter and then we withdraw the grinding wheel backwards. By measuring we satisfy ourselves that the shaft has the desired dimensions and if necessary take off another cut.

When this side is completed, the shaft is taken off the centres, the carrier transferred to the second end (fixing on threads is done by screwing a nut with a dividing cut on to the thread and the carrier may then be fixed on to this nut) whereupon the shaft is again fixed between the centres. The grinding of the second side, stepped down to 50 mm is done in the same way as described above (see drawing 15), care should be taken to maintain the length of 300 — 0.2. After completing the grinding of this diameter we start grinding operations on the 35 mm diameter.

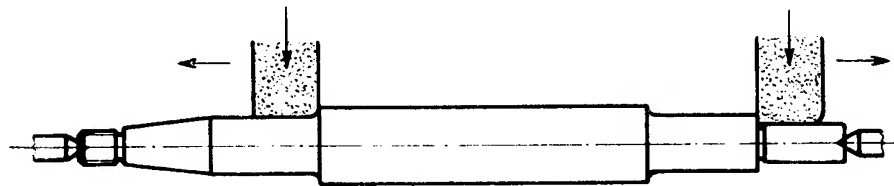


Fig. 16.

The speed of the working spindle is increased to approximately 75 r. p. m. and the table adjusted so that the left edge of the grinding wheel does not yet touch the right edge of the right 50 mm diameter (see drawing 16). Then we bring the grinding wheel forward and by means of hand wheel feed it into cut. As soon as the traces of machining disappear, we withdraw the grinding wheel, measure the diameter (find for instance 35,27) determine the difference between 35m6 (35,02) and 35,27 i. e. 0,25, which we set on the dial under „25“. After bringing the grinding wheel again into cut, we continue by one segment at a time down to zero.

By carefully turning the hand wheel to the right we grind the right front surface of the 50 mm diameter and then by turning the hand wheel to the left, we slowly move the grinding wheel, until its right side overlaps the right end of the shaft by approximately  $\frac{1}{3}$  of its proper width. Thereupon we entirely withdraw the grinding wheel.

After completing the diameter 35 we take the shaft off of the centres, place the carrier on the right ground end (to avoid the damaging of its surface by the screw, use a split bush or a sheet insertion) and fix the shaft again between the centres. It now remains to grind the cone 1:5. In the respective table we find that the setting angle amounts to  $5^{\circ}42'$ . We therefore loosen the screws 141 and by turning the screw 98 to the left, approximately adjust the desired angle and tighten the screws. Then we adjust the stroke of the table as described before (overlap of grinding wheel by  $\frac{1}{3}$  of its width to both sides, see drawing 17) and grind the surface down to make all traces of machining disappear.

By measuring (best by means of a cone ring) we ascertain to which side a correction should be effected and after attaining the correct conical shape we continue to grind in the known way.

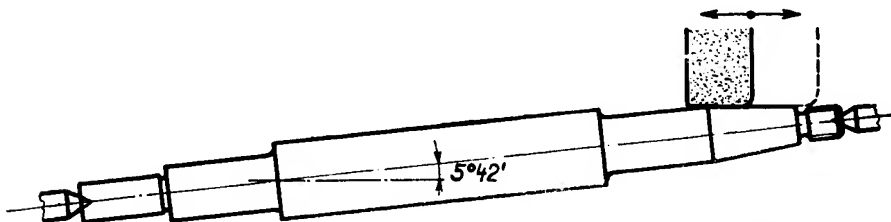


Fig. 17.

**Grinding a larger quantity of identical parts (series).** When grinding a larger quantity of identical parts, we proceed differently than when grinding only single parts.

First we should on all parts grind the first operation (see drawing 14), then the second operation (drawing 15) and so on, eliminating thereby the re-setting of the machine for each part.





The first part of every series is ground as described above to obtain data for the necessary setting-up. For instance when grinding shafts to a diameter of 70 mm by longitudinal grinding, we proceed as follows:

The first shaft was ground down to the correct measure by feeding by means of dial down to zero. By turning the lever 236 to the right and tightening the screw 241 (tighten the screw only softly) we set the control by one lever and the automatic withdrawal of the grinding wheel being equal to the adjusted grinding-down allowance. Then, by turning the button 322 to the left, we set a slightly bigger measure than the allowance on the shaft (in the given case the allowance is 0,5 mm, and therefore we chose the segment „55“) and push in the stop 221. Then we loosen the feed pawl by turning the handle 226 downwards and by means of screw 293 we adjust the feed to the required number of segments (this adjustment of the feed is best effected while the machine runs). We furthermore remark in this connection that the setting of the dial and tightening of the screw must be done when the grinding wheel is approached. When withdrawing the grinding wheel backwards, the hand wheel 174 everytime returns by the set value so that it is not necessary to withdraw the grinding wheel by hand. At the same time the table, spindle and cooling water supply stop.

We now fix the next shaft between the centres and by turning the lever 639 set all simultaneously, i. e. the approach of the grinding wheel forwards, the starting of the spindle, table and cooling water. The feed of the grinding wheel into cut is now automatic according to whether we have set the feed in the right, the left, or both dead end centres and when reaching zero the feed stops. Then we only have to turn the lever 639 to the left, causing the withdrawal of the grinding wheel backwards, re-turning by as much as the allowance, the stopping of the table, spindle and cooling water. When grinding the second operation (see drawing 15) we set, after having ground the first part, the automatic withdrawal by the set allowance as described above, withdraw the grinding wheel, fix the shaft and approach by means of automatic feed, closely besides the diameter 70 mm, to zero. Then we carefully grind down the front and by turning the lever 269 we start action. At the same time good care should be taken that the switch-over lever 195 is in its left position. The table speed for this grinding operation should be as small as possible and after reaching an overlap of the left edge of the grinding wheel by  $\frac{1}{3}$  of its width over the left end of the ground object, we withdraw the grinding wheel backwards.

The same applies for all further operations.

#### Example 2:

We have a task to grind a valve cone as shown in drawing 18, made of chrome-nickel steel, cemented and hardened.

**Allowance for grinding-down** according to table in para III/2, column „C“: to the diameter 20 we add 0,4 mm and to the cone 0,5 mm.

**Grinding wheel** according to table in para II/1 for hardened steel, of Electrite 99, grain 46, hardness L, structure 6.

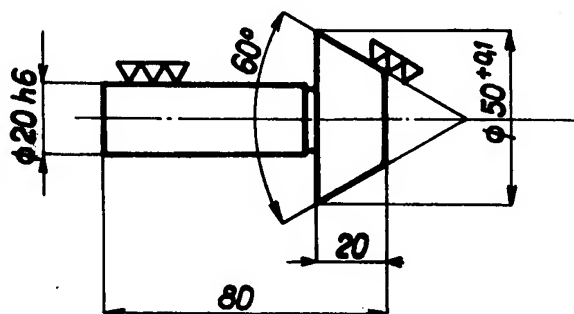


Fig. 18.

**The circumferential speed:** of the part according to table in para IV/1 for roughing hardened steel: 15 m/min., for fine grinding: 9 m/min. This gives for a diameter of 20 mm: 240 and 140 r. p. m., for the cone (medium diameter 40 mm): 120 and 70 r. p. m.



The grinding of the diameter 20 is done between the centres in the way described in the first example. The cone can be ground in two ways: between centres or chucked at one end only, in a chuck or in collets.

**Grinding between centres (drawing 19):** We chose a grinding wheel approximately 25 — 30 mm wide (for reasons of economy) and after balancing we dress it to an angle, corresponding to the angle of the cone.

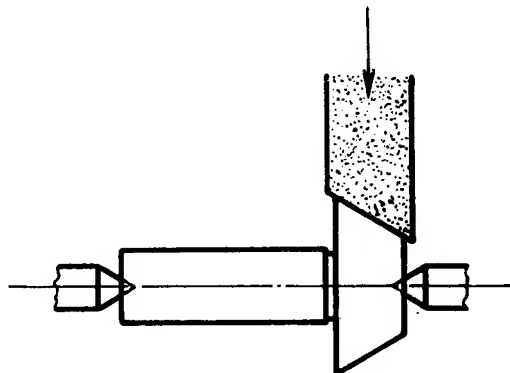


Fig. 19.

We loosen the screws of the revolving plate of the grinding slides and turn it  $30^\circ$  left from zero and again tighten the screws. Now we fix the dressing attachment on to the table and first roughly dress the wheel by means of a disc dresser and then finely by diamond (under water). Thereupon we turn the grinding slides back to zero and can begin with the grinding which is done with the table at stand-still by plunge-cutting to the required measure.

**Grinding of Objects Chucked at One End Only (drawing 20):** The grinding spindle-stock is adjusted according to the operating instructions for grinding in a chuck or in collets. The cone, previously ground down to the diameter 20 is then chucked in a chuck or collet.

Then we loosen the screw 1061 in the axis of rotation of the spindle-stock (on the grinder BK 5 two screws on the revolving plate, below front and back), release the peg fixing the zero position by tightening the nut (on the grinder BK 3 at the left of the screw 1061, on the BK 5 on the cover of the spindle-stock) and the spindle-stock is turned to  $30^\circ$  left of zero, whereupon the screw is again tightened. The grinding is effected by a straight grinding wheel by plunge-cutting method or longitudinal grinding.

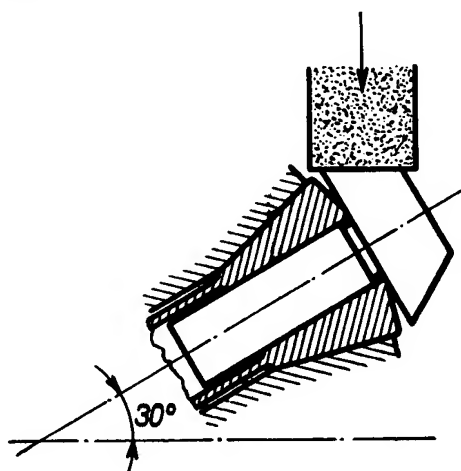


Fig. 20.

### Example 3:

The task is to grind a shift-gear shown on the drawing 21, made of chrome-nickel steel cemented and hardened.



Allowance for grinding-down the plunge according to table in para III/2, column „C“: to the diameter 35 we add 0,4 mm, on the sides 0,2 mm.

When grinding the opening according to table in para VII/3, column „B“: to the diameter 24 we add 0,25 mm.

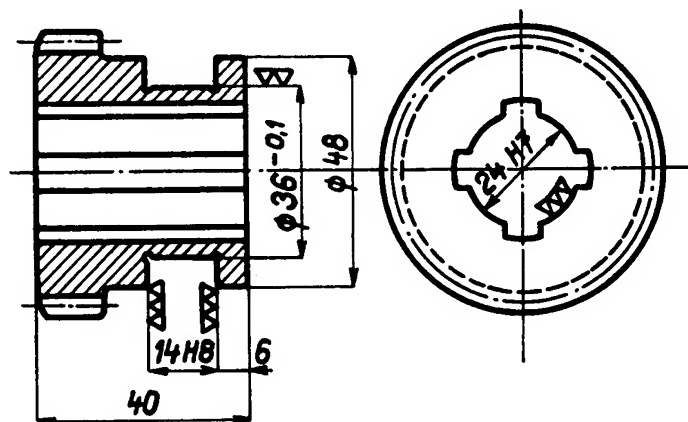


Fig. 21.

Grinding wheel for external grinding according to table in para II/1 for hardened steel from Electrite 99, grain 46, hardness L, structure 6, and for internal grinding from Electrite 99, grain 60, hardness K, structure 5.

The circumferential speed of the part according to table in para IV/1 for fine grinding (plunge-cutting and grinding of the front) 9 m/min. and for internal grinding 18 m/min. This results in 70 r. p. m. for external grinding (medium diameter) and 230 r. p. m. for internal grinding.

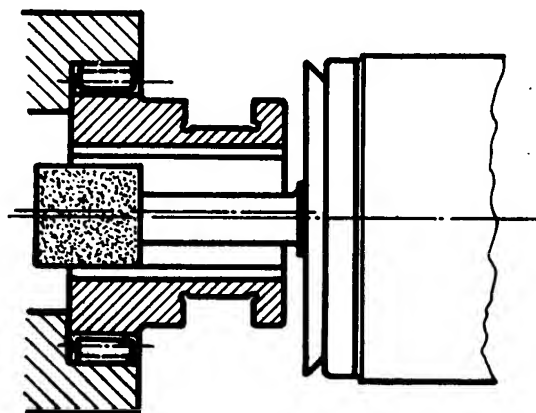


Fig. 22.

**Grinding of the Opening (drawing 22):** We chuck the wheel in the chuck by means of rolls, which are inserted into the clearance between the teeth, whereby we take care of correct centring of same by help of an indicator. According to table on drawing No. 12 we choose the grinding spindle V 70 with internal taper and elongation No. 3, fitted with the wheel of dia. 20×20 mm.

We tilt the arm for internal grinding downwards and ensure same by means of the lever 1852. Before we insert the spindle into the arm, we loosen the clamping screws (internal hexagon) and by screwing-on the remaining two screws, we extend the opening which we clean properly. Upon insertion of the spindle, we loosen the extending screws and tighten correctly the clamping screws. Then we put on the driving belt, which we carefully tighten by means of the stretching pulley. Before we screw-in the elongation with the wheel, we carefully clean the opening in the spindle as well as the taper of the elongation and oil the taper slightly with tallow or oil, thus enabling an easier tightening of same.

The dressing of the grinding wheel is effected by means of a standard dressing attachment, whereby we set the diamond on ground of degrees to the required



diameter of the opening, thus easily enabling grinding to be carried out in series, because by setting the diamond per diameter of the opening measuring becomes unnecessary. (This procedure may also be effected by setting the diamond for a diameter smaller by 0,05 mm and then we polish the opening with a dressed wheel progressively fed in by 0,05 mm — i. e. 5 segments, this bringing equal results. When this method has been chosen one must be especially careful to withdraw the grinding wheel in time before leaving the opening, otherwise the diamond protruding above the ground opening by 0,025 mm would be run on). Adjustment of the stroke of the table is executed in the same manner as when longitudinal grinding, i. e.  $\frac{1}{3}$  of width of the grinding wheel rises over both ends of the opening.

When roughing, we feed into cut approximately by one segment, then we dress the wheel and feed by approximately  $\frac{1}{2}$  a segment when finishing. When grinding the first piece, it is however necessary to measure from time to time, because it is quite obvious that the grinding wheel wears out much quicker than the grinding wheels for external grinding.

**Grinding of a Plunge-cut** (drawing No. 23): The wheel with the ground opening is to be put on a slightly conical pin, which is chucked between the centres when grinding.

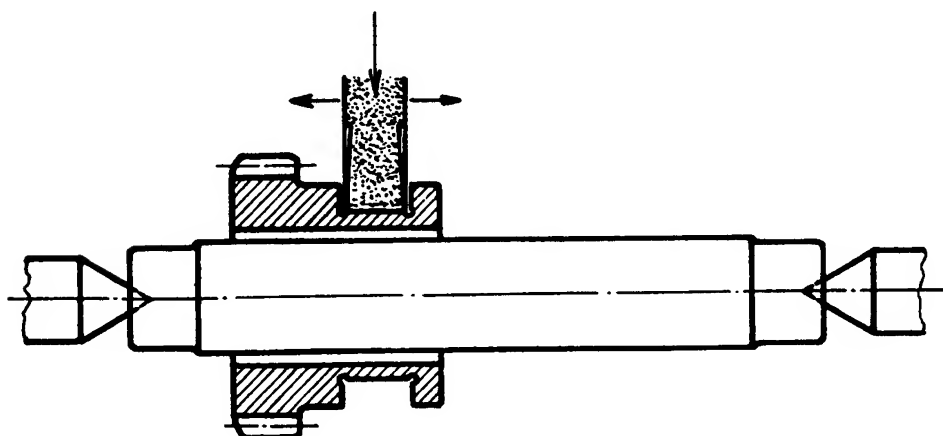


Fig. 23.

The width of the grinding wheel has to be selected according to the width of the plunge-cut, in our case 12 mm. We balance the grinding wheel and dress it. Should the quality of the sides of the ground plunge-cut be decisive, we dress the grinding wheel in such a way that it narrows to its centre (see drawing).

The grinding at the diameter 36 is done by plunge-cut and the grinding of the sides of the plunge-cut by slow fine feeding of the table from the side (wheel 303).

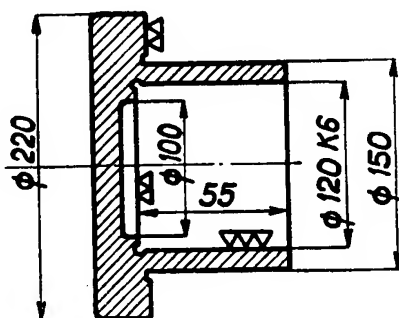


Fig. 24.

#### Example 4:

The task is to grind the bush shown on drawing No. 24 made from grey cast iron.

**Allowance for grinding** of the opening according to table in the para VII/3, column „C”: 0,5 mm is to be added to the diameter, at the fronts 0,2 mm.



**Grinding wheel** according to table in the para II/1 for grey cast iron from Carborundum, grain 36, hardness J, structure 5.

**The circumferential speed** of the part according to table in the para IV/1 for internal grinding 18 m/min., for grinding of the external front 12 m/min. This results in 48 r. p. m. for internal grinding and 25 r. p. m. for grinding of the external front (medium diameter 180 mm).

**Grinding of the Opening** (drawing No. 25): We chuck the bush into a chuck and by help of an indicator the bush is to be centred accurately.

According to table on drawing 12 we select the grinding spindle V 70×450 with external taper and wheel dia. 120×50 mm which we balance properly.

The dressing may be executed both on the circumference as well as on the front of the grinding wheel. If possible, we dress the front with the cross of 1° to 3°, to obtain the flatness of the front surface.

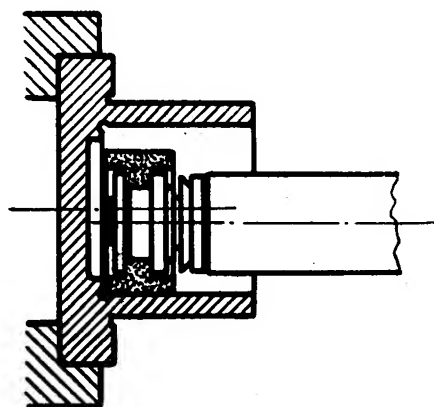


Fig. 25.

The table is moved by hand when grinding whereby we take care not to overstep  $\frac{1}{3}$  of the width of the grinding wheel. Should the distance between the internal front surface and the external steadying surface (the surface contacting the chuck) be decisive, it is advisable to use fixed table stop 1955 with micrometrical adjustment 1951.

**Grinding of the External Front** (drawing No. 26): We grind the external front with a grinding wheel for external grinding, the left side of which has been dressed with the cross of 1° to 3° (see drawing). We feed from the front in full width, whereby we use the fine feed of table (wheel 303).

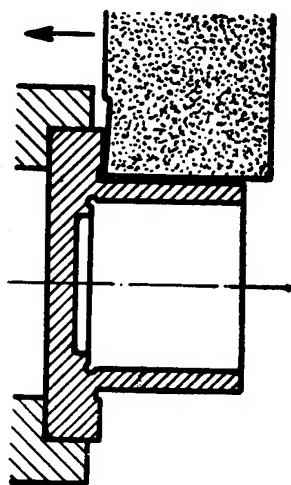


Fig. 26.



## IX. Defects at Grinding, Their Causes and Eliminations.

1. **Symptoms of Vibrations**, appearing in form of small surfaces, caused principally by vibrations.

Cause:	Elimination:
a) Vibrations of the machine.	Balance the grinding wheel or the part, control motors. The grinding spindle-stock or some of the pulleys runs unquietly, one of the bearings is loosened or ball bearing worn out. Test the lubrication of the machine.
b) Vibrations of the machine, caused by external influence (heavy machines in the neighbourhood, cranes, lorries passing by, railway etc.)	Better positioning of the machine, possibly on an insulated base of concrete.
c) The grinding wheel wobbles.	Dress the grinding wheel on the circumference as well as on its sides and balance it. The grinding wheel is too soft—replace it with a harder one, lower the revolutions of the part as well as the speed of table and reduce the feed. Test the setting of spindle and action of the machine.
d) Grinding wheel is too hard, blunt and soiled.	Use a softer or coarser grinding wheel, respectively reduce the depth of cut. Make the grinding wheel coarser by means of a pointed diamond or raise the revolutions of the part. Sometimes a more frequent dressing does the job.
e) The grinding wheel is not properly fixed on to the flange.	Tighten the flange-screws and balance the grinding wheel again.
f) The grinding spindle-stock is not properly set.	Tighten the bearings, control the spindle. The temperature may rise — with good lubrication — up to 60 degrees Celsius.
g) The cut is too deep, the part vibrates.	Support the part by means of steadies (sometimes the jaws of a steady are loosened), reduce the depth of cut or use a coarser grinding wheel.
h) The grinding spindle or the tailstock-sleeve is wrongly set.	Tighten the bearings or the tailstock-sleeve.
i) Wrong fixing of grinding spindle-stock or tailstock on the table.	Tighten the screws.
j) The centres are not properly set in the internal taper of the grinding spindle or the tailstock-sleeve.	Surface the centres.
k) The revolutions of the part are too high.	Regulate the revolutions according to the para IV/1.
l) The part is loose between centres.	Move the tailstock closer to the grinding spindle-stock or raise the pressure of the tailstock-sleeve spring, eventually remove the tailstock-sleeve and clean it and re-grind the worn centres.
m) The part is not balanced.	Balance the part or reduce the revolutions of same, or do both if necessary.
n) The centring corners are too small or covered with scale.	Keep the centring corners large, clean and round.



Cause:	Elimination:
o) Ground without cooling, especially when grinding tubes.	Plentiful, properly divided stream of cooling water.
p) Cooled only by means of water without additional grinding oil (this happens when grinding certain materials).	See the para VI.
q) Too small number of steadies on hand.	Distribute the steadies properly (see the para V/1).

**2. Beams** running in the direction of surface lines in a distance of  $\frac{1}{4}$  to 2 mm. Same are usually so shallow that they cannot be measured and can be seen by eye only. After the ground surface has been touched in its whole length by a ring or pin, then they appear in the form of bright stripes.

Cause:	Elimination:
a) The grinding spindle plays.	Tighten the bearings, if necessary re-scrape.
b) Vibrations of machine.	See „Symptoms of vibrations“ para a) and b).
c) The grinding wheel wobbles or is too blunt.	See „Symptoms of vibrations“ para c) and d).
d) The grinding spindlestock or tailstock-sleeve are not properly set.	Tighten or re-scrape the bearings, tighten the tailstock-sleeve.
e) The geared wheels in the grinding spindle-stock do not run properly.	Replace all engaging geared wheels with new, faultless ones.
f) The part is loose between centres.	See „Symptoms of vibrations“ para l).
g) The centring corners are too small.	Enlarge the corners and grind same properly and spherically. Should the part be too small, chuck same into a chucking collet or between hollow centres.
h) Small number of steadies on hand.	See „Symptoms of vibrations“ para q).

**3. Marks on the Surface** of parts, similar to those of the chess-board etc.

Cause:	Elimination:
a) The grinding wheel is partly soiled by pieces of metal.	The grinding wheel must run symmetrically - control the drive (see also the paragraph „Soiled grinding wheel“).
b) The grinding wheel wobbles.	See „Symptoms of vibrations“ para c).
c) The cut is too deep, the grinding wheel jerks.	Decrease the depth of cut or use a coarser grinding wheel with open structure.
d) The part vibrates, small number of steadies on hand.	Use more steadies or tighten their jaws a little more.
e) The steady-jaws are running dry.	Lubricate the jaws or regulate the stream of cooling water better.

**4. Drawn marks at fine grinding.**

Cause:	Elimination:
a) The cooling water is not clean.	Clean the water by help of a special sedimental attachment and filter.
b) The grinding wheel loosens prematurely its grains.	Re-dress the grinding wheel slowly with a sharp diamond or use a harder grinding wheel.
c) The grinding wheel is soiled by pieces of metal.	The grinding wheel must run symmetrically. Use a shallower cut (see also paragraph „Soiled grinding wheel“).

**5. The Ground Part Is Not Round.**

Cause:	Elimination:
a) The centring corners are not clean.	Clean the corners.
b) The centring corners are not round.	Surface the corners, grind them or lap them with a cast iron pin and emery.
c) The part is not balanced.	Reduce the revolutions or balance the part (counterweight).
d) The fronts of the parts are not flatly turned.	Re-turn the fronts of the ends of part.
e) The part does not revolve symmetrically.	Control the drive.
f) The grinding spindle is not round (by chuck grinding).	Re-grind the spindle and re-set the bearings.
g) The cooling is insufficient.	More of cooling water (stuffed inlet).

**6. Screw Line on the Part.**

Cause:	Elimination:
a) The grinding wheel is too fine or too hard and the cut is too deep.	Use a corser and softer grinding wheel. Often coarsing and chamfering of edges does the job.
b) The grinding wheel is unsymmetrical and not properly dressed.	Re-dress the grinding wheel on its circumference as well as on both sides.
c) One side of grinding wheel grinds dry.	Sufficiently strong and properly divided stream of water.
d) Too high speed of table.	See para IV/3 about the speed of table.
e) The table tilts in the guiding.	Scrape and control the drive.

**7. Burned Places and Cracks.**

Cause:	Elimination:
a) The grinding wheel is too hard or fine, it is blunt and shines.	Use a softer or coarser grinding wheel, often coarsing with a pointed diamond does the job.
b) The cut is too deep.	Decrease the depth of cut.
c) The revolutions of the part are too low.	See paragraph IV/1 about the revolutions of the part.
d) The speed of table is too high.	See para IV/3 about the speed of table.





Cause:	Elimination:
e) Insufficient cooling.	Divide better and re-inforce the stream of water, eventually increase the contents of grinding oil.

### 8. The Part is in the Middle Thicker.

Cause:	Elimination:
a) Small number of steadies on hand or not properly tightened jaws of the steadies.	See para V/1 about using of steadies. Control the tightening of jaws.
b) The grinding wheel protrudes on the ends too far above the end of part.	Set correctly the stroke of table.

### 9. The Part is in the Middle Thinner.

Cause:	Elimination:
a) When grinding short parts: The grinding wheel is not cylindrical.	Re-dress the grinding wheel.
b) When grinding long parts: the table does not run straight on.	Re-scrape the guiding of table (Has to be done by an expert).
c) The jaws of steadies are tightened too much.	Do not tighten the jaws so much.

### 10. Coarse Surface When Front Grinding.

Cause:	Elimination:
a) The grinding wheel has an axial play.	Control the internal setting.
b) The grinding wheel was not dressed on its side.	Dress the grinding wheel not only on its circumference but also on its sides cross-wise towards its centre.
c) The grinding wheel is too hard or fine because the contacting surface is larger than by round grinding.	Increase the revolutions of the part, use a coarser grain, eventually a softer grinding wheel or a more open structure.

### 11. The Openings Are Enlarged on Their Ends.

Cause:	Elimination:
a) The Grinding wheel protrudes too far above the ends of openings.	See paragraph VII/2.
b) The grinding wheel is too hard and fine.	Use a softer or coarser grinding wheel.

### 12. Soiled Grinding Wheel.

Cause:	Elimination:
a) The grinding wheel is too fine and hard.	Use a coarser grinding wheel or coarse same better. Increase the revolutions of the part.



Cause:	Elimination:
b) The cut is too deep.	Decrease the depth of cut or use a coarser grinding wheel.
c) The surface of the part is soiled by scale.	Use a coarser grinding wheel or coarse it better. Clean the part in a sand spouter.

### 13. Small Parts of Material Remain on the Grinding Wheel.

Cause:	Elimination:
a) The grinding wheel does not run symmetrically.	Control the drive, tighten the belts.
b) The grinding wheel wobbles.	See „Symptoms of vibrations“ para c).
c) The cut is too deep, the part overheats.	Decrease the depth of cut or use a coarser grinding wheel with a more open structure. Water more.
d) The part does not run symmetrically.	Control the drive of the grinding spindle, especially the driving of part.

### 14. Untimely Blunt and Shining Grinding Wheel.

Cause:	Elimination:
a) The grinding wheel is too hard or fine. The revolutions of the part are too low.	See para II about grinding wheels and para IV/1 about revolutions of the part.

### 15. The Grinding Wheel Strikes.

Cause:	Elimination:
a) The grinding wheel is not round, it wobbles.	See „Symptoms of vibrations“ para c).
b) The revolutions of grinding wheel are too low.	See para II/2 about circumferential speed.
c) The grinding wheel is not balanced.	Dress and balance the grinding wheel.
d) The grinding spindle is loose in its bearings.	Limit the play.
e) The revolutions of the part are too high.	See para IV/1 about revolutions of part and para II/2 about the circumferential speed of the grinding wheel.
f) The part vibrates.	Support the part better by means of steadies.
g) The part shakes.	Control the setting of the machine, working spindlestock and tailstock and centres.
h) Insufficient supply of water.	Strengthen the stream of water, see also para VI about cooling.

### 16. Immoderate Wearing Out of Grinding Wheel.

Cause:	Elimination:
a) The grinding wheel is too soft.	Use a harder grinding wheel.



## X. Elimination of Eventual Stoppages of the Machine.

When using the grinding machines, various disturbances may sometimes occur, caused either by incorrect operating of the machine, insufficient lubrication or using of inconvenient lubricating oil, penetrating of impurity into the oil, etc.

Further possibilities of disturbances are connected with the electrical outfit of the machine. The most frequent disturbances in this respect are stated hereunder:

### 1. The Grinding Spindle Does Not Revolve.

Cause:	Elimination:
a) The bearing bushes are tightened too much.	Loosen the bearing bushes.
b) Seized spindle in some of its bushes resulting from immoderate tightening or insufficient lubrication.	Dismantle the spindle (see Operating Instructions), polish or re-grind the damaged spot on the spindlestock and re-scrape the damaged bush again.

### 2. The Lubrication of the Grinding Spindle Does Not Operate.

Cause:	Elimination:
a) The strainer on the suction-muzzle of the lubricating pump is stuffed by impurities.	Let the oil of the grinding spindlestock flow out, clean the strainer and the inside of the spindlestock, then re-fill with new, clean oil.

### 3. Inaccurate Approaching of Grinding Slides.

Cause:	Elimination:
a) The oil is too cold (when starting the machine).	Switch the motor of the pressure pump on immediately on coming to the machine in order that the oil will have the proper operating temperature when starting the work.

### 4. The Feed Into Cut Does Not Operate.

Cause:	Elimination:
a) The ratchet is lifted.	Set the handle 226 downwards.
b) The ratchet remained lifted even after turning the handle 226 into the correct position.	<p>The disturbances b) to d) can be ascertained when removing the hand wheel 174 after loosening of four screws of the supporting ring of the screw 241 and screwing of same out. Then we at first remove the hand wheel from the shaft and thereupon the dial in order not to damage the indicator of segments.</p> <p>To point b): push the ratchet downwards and control the function of lifting and sinking repeatedly approaching and withdrawing of the grinding slides. Should the ratchet still be hitched, remove the ratchet wheel and screw off the closing nut of the lifting piston. Remove the piston with the spring and clean everything properly.</p>

**Cause:****Elimination:**

- |  |   |
|--|---|
| c) The ratchet of the ratchet wheel is broken-off.   | To point c): remove the feeding cog out of the ratchet, grind a new edge and fit it in again.   |
| d) The spring of the feeding arm is drawn out and this was caused by turning the hand wheel to the left without having disengaged the ratchet. | To point d): replace the drawn-out spring with a new one.   |
| e) The button 241 for switching-on the reverse movement by the allowance for grinding-down is tightened too much.                              | Loosen the button 241 and tighten it moderately again.  |
| f) When using independant feed into cut, same is too slow (insignificant passage through the choking valve stuffed by impurities in oil).      | Turn the button 214 serving for setting the speeds of the independant feed into cut to the right or the sign „quickly“ whereby the outlet for the impurity will be opened. Then turn the button into its previous position again. |

**5. The Table Has a Broken Movement.****Cause:****Elimination:**

- |   |  |
|---|--|
| a) Insufficient lubrication of guiding surfaces of the table (caused by small strokes or inconvenient oil). | Should the stroke of table be too small give the table full stroke a few times in order that the guiding surfaces can draw the oil from the lubricating rollers. Exchange the inconvenient oil against engine-oil of 16 <sup>0</sup> E viscosity.  |
| b) Faulty tightening sleeves (thin leather etc.).   | Remove the piston rod 539 from the table and the right cover of the guiding surfaces as well (on the machine BK 3 the spring 115, on the machine BK 5 the front plate 91) whereupon move the table so far to the left until it is made possible to reach the left side of the cylinder. Support the table with a wooden stand. Then remove the lid of the cylinder 525 (on machine BK 5 it is necessary also to detach the inlet of oil from the lid of the cylinder) and pull the piston rod with the piston out. After exchanging the sleeves re-built vice versa. |
| c) Loosened nuts 558, piston rods 539.  | Tighten the nuts properly!   |

**6. Engaging and Disengaging of the Grinding Spindle and Cooling Pump Does Not Operate (one-lever control).****Cause:****Elimination:**

- |  |   |
|--|---|
| a) Faulty function of the end contact in the rear part of stand (see picture 4 and 4a in the Operating Instructions - end contact 1682 and piston 1328). | Remove the cover 1682 of the end contact in order to be able to watch the function when approaching and withdrawing the grinding slides and set the choking valve, pre-ranged to the piston 1328 into the position thus making possible the contactors to switch on and off properly. Should it be necessary, remove the piston 1328 and clean it (collected impurities). |
|--|---|



**7. One of the Motors Does Not Run.**

Cause:

Elimination:

- |   |  |
|---|--|
| a) The thermal relais of the concerned contactor is switched-off. | Open the door 1589 on which the electric gears are mounted and switch-on the disengaged relais by pushing in the lever protruding out below the round opening of the thermal relais. |
|---|--|

**8. One of the Signal Bulbes Does Not Shine.**

Cause:

Elimination:

- |   |  |
|---|--|
| a) The thermal relais is switched-off (the motor will not start running). | Switch-on the relais.  |
| b) Faulty bulb (the motor starts running, the bulb does not shine).       | Exchange the bulb. The transparent cover of the bulb may be pulled out by means of a screw-driver inserted below its border. |

**9. The Regulation Motor of the Grinding Spindle-stock at the Machine BK 3 Does Not Thrust Well.**

Cause:

Elimination:

- |                                       |  |
|---------------------------------------|--|
| a) Faulty carbons of collector rings. | Screw-off the cover of the collector rings and replace the worn carbons with new ones. |
|---------------------------------------|--|

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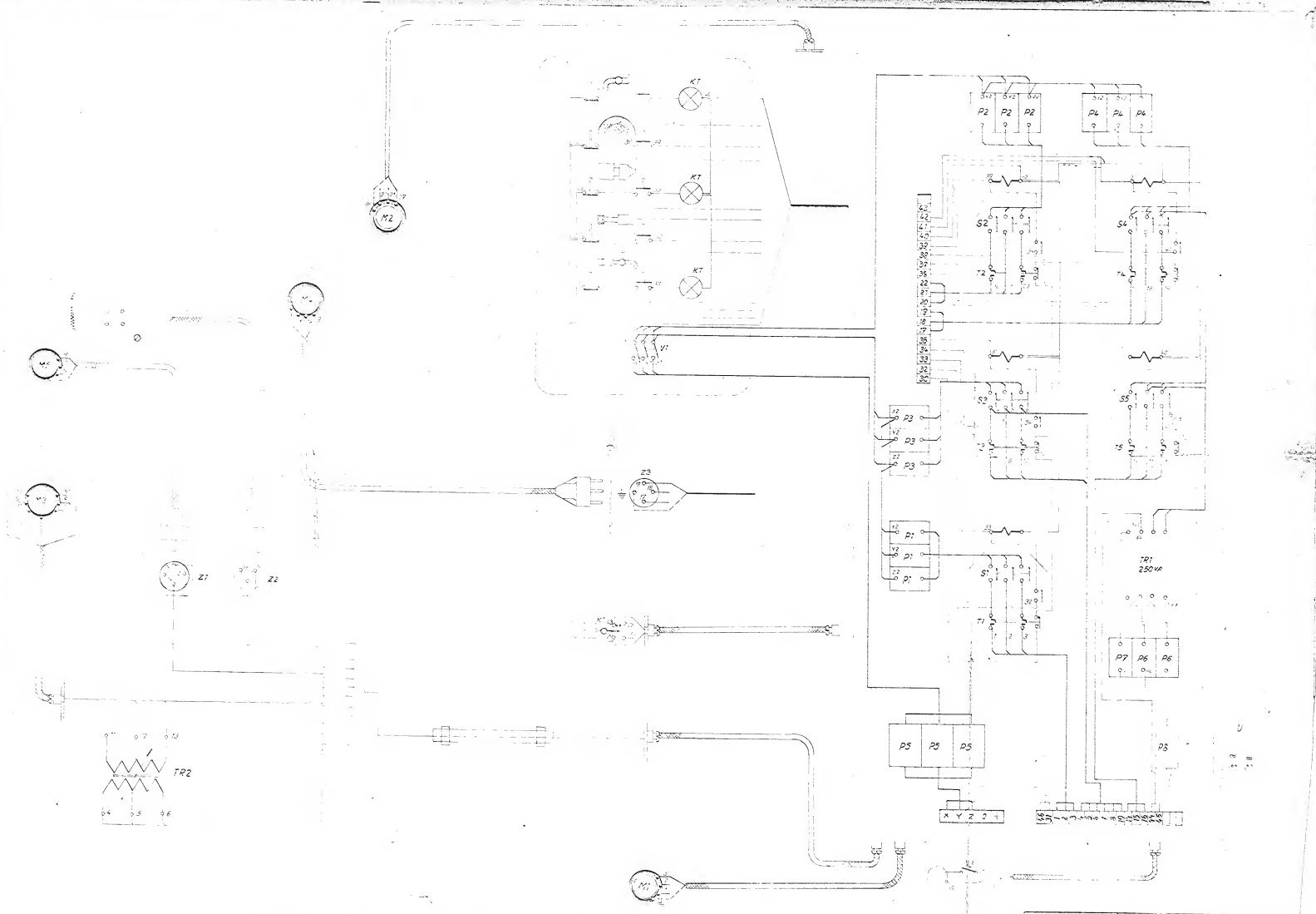
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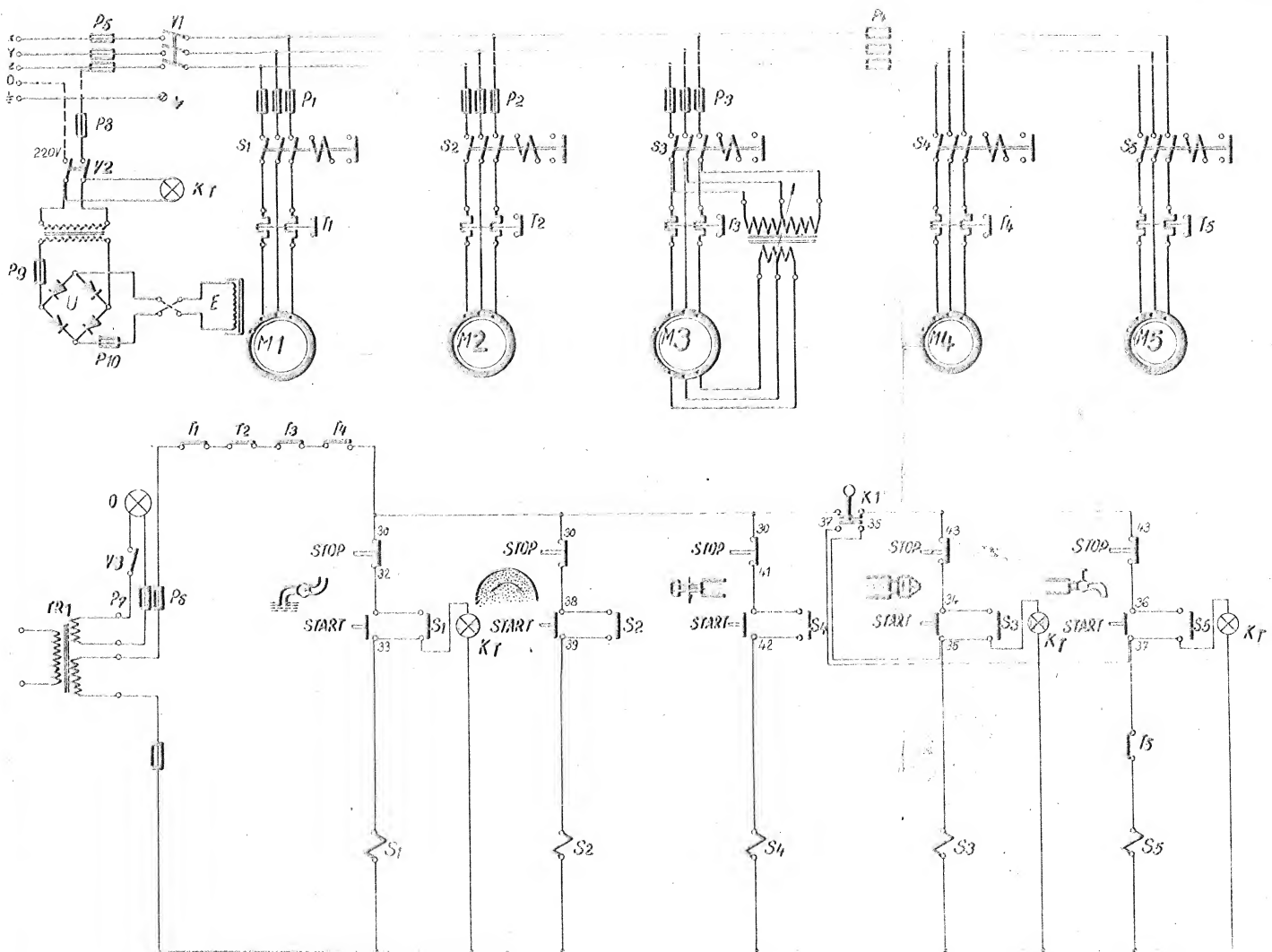
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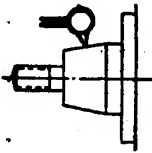
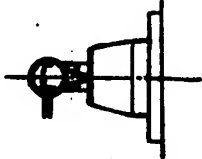
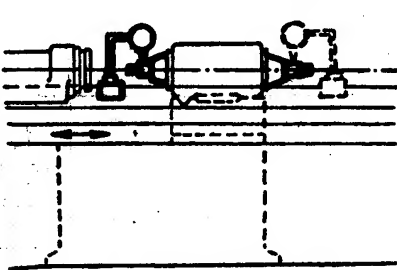
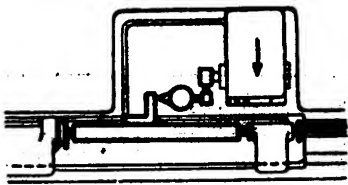
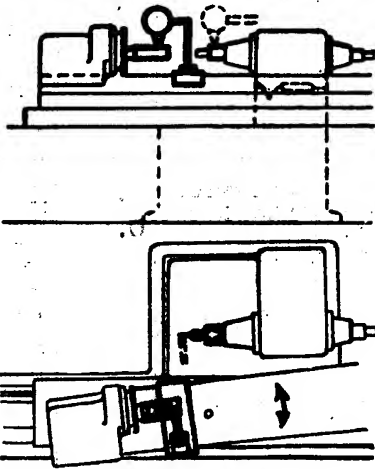
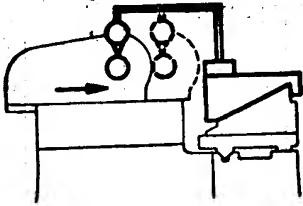
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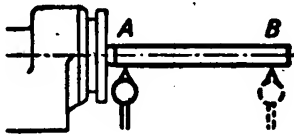
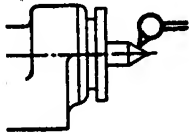
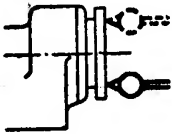
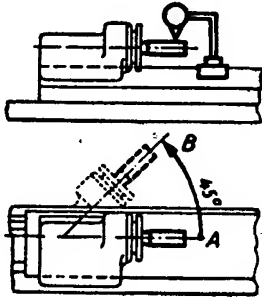
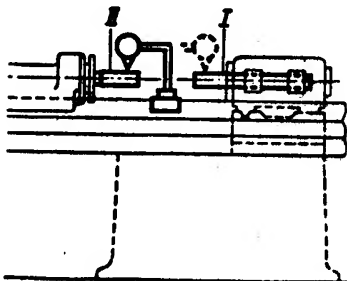
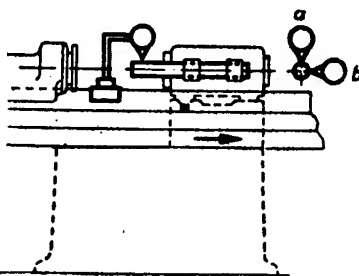
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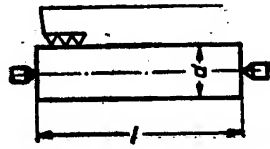
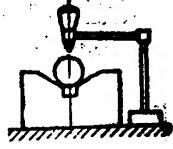

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		Inspection Sheet (accuracy limits on machine tools) <b>CYLINDRICAL GRINDING MACHINES</b>				
No.	What measured	Figure	Measurement taken by	Error admissible	Error actual	Testing method
6	Cone of work spindle runs out on its circumference		Dial indicator	0.01 mm	0.005	Indicator set perpendicularly upon the surface line of cone. Turn spindle and read declinations.
7	Wheel spindle for axial slip		Dial indicator	0.01 mm	0.01	Indicator fixed in table and adjusted. Turn spindle and read declinations.
8	Wheel spindle parallel with table movement a) in vertical plane b) in horizontal plane		Dial indicator	0.01 mm	0.01	Indicator fixed on table and adjusted. Traverse table by measured amount and read declination.
9	Movement of wheel slide perpendicular to work headstock and tailstock		Mandrel with centre holes Angular gauge Dial indicator	0.01 mm on the entire length of wheel slide travel	0.005	Top table in zero position. Wheel slide in rear position. Mandrel held in centre, angular gauge set on mandrel. Indicator fixed on wheel slide and set on free end of angular gauge. Traverse wheel slide by the longest way possible.
10	Axis of wheel spindle at one height with work spindle axis		Mandrel with 100 mm long cylindrical part Dial indicator	±0.2 mm	0.04	Wheel slide in middle position. Mandrel held in work spindle. Indicator located on top table and set on free ends of mandrel and shaft. Read declinations. Swivel top table according to scale and repeat measurement.
11	Height of wheel spindle over table equal in both extreme end positions of wheel slide		Mandrel with 100 mm long cylindrical part (way of mounting as per type of machine tested) Dial indicator	0.05 mm on the entire length of wheel slide travel On machines with swivelling wheel slide error allowed only to be within 0.02 mm	0.01	Wheel slide in rear position. Mandrel fixed on wheel spindle. Indicator on top table and set on mandrel. Read declination. Traverse wheel slide into front position and repeat measurement.

\*) Measurement may be taken directly on spindle if the latter is fitted with special collars.

		Inspection Sheet (accuracy limits on machine tools) <b>CYLINDRICAL GRINDING MACHINES</b>				 25X1
No.	What measured	Figure	Measurement taken by	Error admissible	Error actual	Testing method
12	Cone of work spindle runs out on its circumference		Mandrel with conical shaft and with 300 mm long cylindrical part Dial indicator	In pos. A 0.01 mm In pos. B 0.02 mm	0.01 0.02	Mandrel held in work spindle. Indicator set on mandrel. Turn spindle and read declination. Measurement to be taken in pos. A, B.
13	Centre of work spindle runs out on its circumference		Dial indicator	0.01 mm	0.005	Set indicator on centre perpendicularly to surface line of cone. Turn spindle and read declination.
14	Work spindle and face of backplate of chuck for axial slip		Dial indicator	0.01 mm	0.01	Set indicator on face of backplate or on spindle nose. Turn spindle exerting simultaneously axial thrust on spindle in the direction towards grinding wheel. Read declination. Measurement to be performed in both opposite lying positions.
15	Height of work spindle axis remaining the same if work headstock swivelled to 45° position		Mandrel with conical shaft and with 100 mm long cylindrical part Dial indicator	0.02 mm	0.01	Mandrel held in work spindle. Indicator on top table, set on free end of mandrel. Read declination. Measurement to be taken in pos. A (axis of work spindle parallel with slide ways). Loosen work headstock, swivel same by 45° and lock it in this position. Repeat measurement in this new position of work headstock.
16	Axis of internal grinding spindle coinciding with axis of work spindle		Mandrel I with 100 mm long cylindrical part and with cylindrical part to be held by in the hole for internal grinding spindle Mandrel II with conical shaft and with 100 mm long cylindrical part Dial indicator.	0.02 mm	0.02	Mandrel I held in hole for internal grinding spindle. Mandrel II held in work spindle. Dial indicator on top table and set alternatively on mandrel I and II. Read declination.
17	Axis of internal grinding spindle parallel with table movement a) in vertical plane b) in horizontal plane		Mandrel with 100 mm long cylindrical part and with cylindrical part to be held by in hole for internal grinding spindle Dial indicator.	a) 0.02/100 mm b) 0.02/100 mm	0.01 0.01	Mandrel held in hole for internal grinding spindle. Indicator located on top table and set on mandrel. Traverse table by the measured amount and read declination.

\*) Tests under Nos. 16 and 17 are to be performed only on Universal Grinding Machines fitted with Internal Grinding and Facing Attachments.

		Inspection Sheet (accuracy limits on machine tools) <b>CYLINDRICAL GRINDING MACHINES</b>																							
No.	What measured.	Figure	Measurement taken by	Error admissible	Error actual	Conditions of work	Testing method																		
18	Working accuracy for grinding between centres a) machine grinds round within b) machine grinds cylindrically within	<p><i>finish ground</i></p>  <table border="1"> <thead> <tr> <th>Max. grinding length of the machine</th> <th><i>l</i></th> <th><i>d</i></th> </tr> </thead> <tbody> <tr> <td>model BK 400 . .</td> <td>300</td> <td>45</td> </tr> <tr> <td>.. 500 . .</td> <td>300</td> <td>45</td> </tr> <tr> <td>.. 750 . .</td> <td>500</td> <td>60</td> </tr> <tr> <td>.. 1000 . .</td> <td>750</td> <td>80</td> </tr> <tr> <td>.. 1500 . .</td> <td>1000</td> <td>100</td> </tr> </tbody> </table>	Max. grinding length of the machine	<i>l</i>	<i>d</i>	model BK 400 . .	300	45	.. 500 . .	300	45	.. 750 . .	500	60	.. 1000 . .	750	80	.. 1500 . .	1000	100		a) 0,005 mm b) 0,01/300 mm 0,01/500 mm 0,015/750 mm 0,02/1000 mm	<b>0.002</b> - <b>0.005</b> - -	Manufacturer has to state: Kind of grinding wheel (grain, hardness), material of test piece, circumferential speeds and feed. To be ground between dead centres. Test piece must not be supported by steady.	  b) Finish-ground work piece must be accurately cylindrical.
Max. grinding length of the machine	<i>l</i>	<i>d</i>																							
model BK 400 . .	300	45																							
.. 500 . .	300	45																							
.. 750 . .	500	60																							
.. 1000 . .	750	80																							
.. 1500 . .	1000	100																							

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